ANNALS OF BRITISH GEOLOGY,

1891.

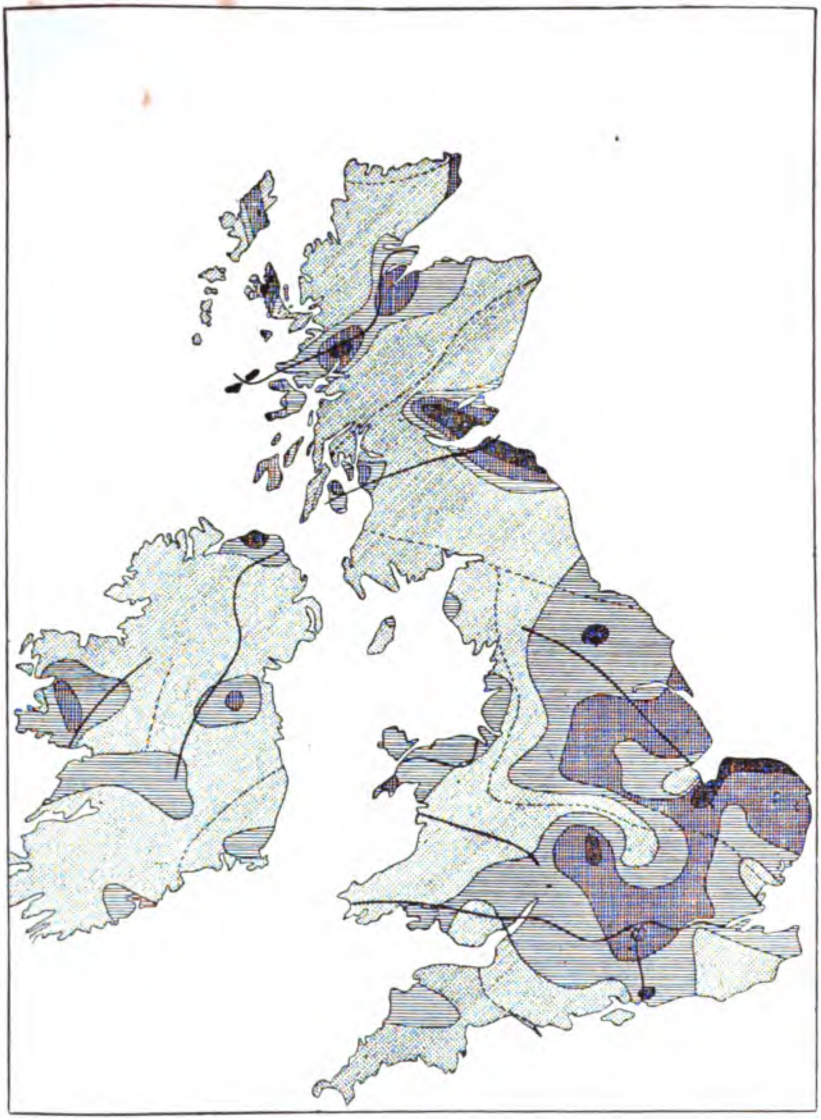

PLATE I.—Magnetic-disturbance map of the British Islands.

Dotted areas are those in which the vertical intensity is less than the mean; lined areas where it is greater—three degrees of increase being indicated by deeper shading. The black curving lines are "Ridge Lines," the broken ones are "Valley Lines." See No. 3.

ALS

ITIS OLOGY.

ANNALS

OF

BRITISH GEOLOGY,

1891.

A DIGEST OF THE BOOKS AND PAPERS PUBLISHED
DURING THE YEAR—
WITH OCCASIONAL NOTES.

BY

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President of the Geologists' Association

WITH SIX PLATES.

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PREFACE.

THE present Volume differs in some noticeable respects from the first. No notice is now taken of papers read, but not published—the book is quite full enough without them. The "Personal Items" are dropped—they do not seem to have been much appreciated. These are the minor changes. The comments which have been thought necessary on the various papers have now been put in the form of foot-notes, and their character has, perhaps, been somewhat modified. In the previous volume, they do not appear to have been taken altogether in good part. Even friends have been sarcastic, and one writer, whom one would wish to respect, completely lost his temper over them, and wrote a libel instead of a review. Being intercalated in the body of the articles, they certainly seemed to savour of interruptions, and in some cases may have served no useful purpose. It is hoped that the notes in the present volume may be found useful. Wherever possible, both the abstract and my notes have been submitted to the authors, and those which have been received back corrected are marked with an asterisk. I can hardly thank those authors too much for the trouble they have taken in the matter. In this way the reliability of the abstract is very much increased, and some of the comments have been rendered unnecessary, though the process has rather delayed the publication. I am not aware that in any previous "Records" this method has been adopted. A new departure is also taken in the introduction of illustrations of all new British species, and of other important novelties. These, however, might be much improved by the co-operation of authors in lending clichés, of which a commencement has been kindly made by Mr. F. A. Bather.

The first volume contained an account of 560 publications, the present one includes 650, with 20 additional for 1890, and the abstracts are fuller, so that in spite of the excision of the unpublished papers the number of pages is considerably increased. The year 1891 has certainly been prolific of important works, amongst which may be mentioned the Magnetic Survey of the British Isles, the "Challenger" Report on Deep-Sea Deposits, and the British Museum Catalogues of Fossil Birds and Fishes and Eocene Mollusca.

I have to acknowledge with grateful thanks the aid of Messrs. L. Fletcher, J. J. H. Teall, and A. S. Woodward in looking over particular parts which were doubtful.

In conclusion, it should be stated that the quality of the support which this publication has as yet received is more gratifying than the quantity; the first volume has resulted, at present, in a considerable loss; the present one promises to be much more successful, but the series can only be continued beyond a third volume if it be made, at least, self-supporting.

J. F. BLAKE.

November 30, 1892.

TABLE OF CONTENTS.

CORRECTIONS.

P. 1, line 7, delete "Proc."
P. 2, line 4, add *; line 7, after "that" add "part of"; line 16, for "xlix. B." read "clxxxi A."
P. 5, line 7, for "K" read "κ."
P. 6, line 30, add *.
P. 7, line 26, for "Jamaica" read "Barbados."
P. 10, line 6, after "contain" add "not less than."
P. 11, line 12, for "into" read "beyond."
P. 12, line 41, for "clays" read "muds."
P. 13, line 33, for "pelagic" read "terrigenous."
P. 14, line 16, for "$CaCO_3$" read "$CaSO_4$."
P. 15, line 10, after "bottom" add "over deep sea terrigenous deposits, and abyssal over pelagic deposits"; line 40, after "two" add "stations."
P. 19, line 45, for "corals" read "sponges."
P. 23, line 35, add "with additional data referring to the deposits."
P. 24, line 2 from bottom, add *.
P. 26, line 37, add *.
P. 32, line 1, add *; line 33, for "assumes will" read "concludes will at least"; line 35, after "same" add "or a greater"; line 42, add *; line 45, for "Chamounis" read "Chamounix."
P. 33, line 2, for "course" read "coarse"; line 11, after "sulphate" read "of lime"; line 12, after "lime" read "and magnesia."
P. 34, line 3, add *; line 43, after "expected" add "in cutting the main sewer of Naples"; line 45, add *.
P. 35, line 3, after "in" add "Beautiful spire-like fumaroles then formed are described and figured."
P. 43, line 24, add *.
P. 47, line 19, add *; lines 29, 32, for "Bausal" read "Barisal."
P. 49, line 38, add *; line 51, after "London" add "Philip and Son."
P. 50, line 37, for "52·81" read "62·81.'
P. 83, line 4, add *.
P. 85, line 6, for "Bailey" read "Baily."
P. 92, line 3, add *.
P. 95 line 20, add *; line 30, for "in cavities of" read "resting on."
P. 108, line 41, add *; line 46, after "organisms" add "chiefly sponges."
P. 134, line 3, add *" line 8, delete "or descending."
P. 135, line 25, add *; line 33, before "the rest" add "most of"; line 34, delete "except in the extreme west."
P. 136, line 4, after "or" add modified"; line 39, add *.
P. 151, at bottom, add "Trans. Manchester Geol. Soc., vol. xxi., p. 197."
P. 201, line 3, for "326" read 326A"; line 20, add *.
P. 219, line 12, for "fig. 53" read "fig. 54."
P. 224, line 38, for "xi." read "xii."
P. 225, line 15, for "fig. 57" read "fig. 51."
P. 234, line 5, for "fig. 57" read "fig. 37."
P. 243, line 18, add *.

*An * before an article indicates that the abstract has been received back from the author, or editor, corrected.*

ANNALS OF BRITISH GEOLOGY.

⊲ 1891. ⊳

GENERAL GEOLOGY.

GENERALITIES.

***1. Love, A. E. H.—On Sir William Thomson's Estimate of the Rigidity of the Earth.**

Trans. Camb. Phil. Soc., vol. xv., part 1, p. 107, Proc.

Sir William Thomson's [Lord Kelvin] problem was to determine the amount of tidal deformation in the earth, supposed elastic but not compressible. The author attacks the more general problem by allowing it to be compressible. In the mathematical treatment of this, the tidal deformation of the earth is taken as dependent on a quantity ϵ, which is shown to be a rational function of a second quantity δ, which $=\frac{\frac{1}{3}g\rho a}{n}$, where g = gravity at surface, ρ = mean density, a = mean radius, n = resistance to distortion. When the body is incompressible the equation arrived at is

$$\epsilon = \frac{15\,\delta}{6\delta + 19}$$

and when the resistance to compression $= \frac{5n}{3}$, as is the case with most hard solids, the equation is

$$\epsilon = \frac{225\,\delta^{1}}{93\,\delta + 285}$$

For a rigidity equal to that of glass $\delta = 5$, and for one equal to that of steel $\delta = \frac{5}{8}$. For either value the two above equations give almost identical results for ϵ—in fact, the curve representing the one closely agrees throughout with that representing the other; consequently it makes very little difference in the solution of the problem which assumption

[1] A different equation to this is given in the paper, but the author has since found the above to be the correct one; see his "Treatise on the Mathematical Theory of Elasticity," vol. i., p. 303.

about the compressibility we make. If $\delta = \frac{8}{3}$ (steel) $\epsilon = \frac{4}{5}$, if $\delta = 5$ (glass) $\epsilon = \frac{3}{2}$, if $\delta = \infty$ (water) $\epsilon = \frac{5}{2}$.[1]

UNDERGROUND TEMPERATURE.

2. McDakin, Capt.—On the Internal Heat of the Earth, and some remarks upon Volcanoes.

"The South-Eastern Naturalist," vol. i., p. 54.

Suggests that the internal heat is due to the oxidation of organic matter, and has experimentally shown that permanganate of potash, poured over garden mould, raises the temperature, and this suggestion is then generalised, so that the heat is considered due to "chemical action" unrestrictedly.[2]

MAGNETIC PHENOMENA.

*3. Rücker, A. W., and Thorpe, J. E.—A Magnetic Survey of the British Isles for the Epoch of Jan. 1, 1886.

Phil. Trans., vol. xlix., B., pp. 53–328, pls. i.–xiv.

The basis of this work is the determination of the Declination, Inclination, and Horizontal Force at 200 stations scattered over the British Isles. From these data the "true" isomagnetic lines are drawn, and their deviations from the mean "terrestrial" ones give indications of underground disturbing forces. For this purpose, the isogonal lines, and the lines of equal horizontal force, are most useful—the isoclinals being affected by the possibility of a constant error of unknown amount. Where the disturbance of the mean horizontal force changes sign, we must pass either over a central line of attraction, here called a "ridge line," or over the boundary between the ranges of influence of one line of attraction and another, here called a "valley line." The disturbances of the declination, in the same way, may change sign on crossing another set of lines. Where the ridge line of one system intersects that of another, we have a magnetic "peak."

Particular districts are then dealt with, and it is pointed out that if the attracting mass is more or less vertical, and is

[1] The bearing of this result on the rigidity of the earth may be easily explained. The water tides are represented by the number $\frac{5}{2}$; if the earth tide is represented by ϵ_1—then the observed tide is $\frac{5}{2}-\epsilon_1$. The ratio of the observed tide to the tide calculated on an absolutely rigid earth is $\frac{\frac{5}{2}-\epsilon_1}{\frac{5}{2}}$; this quantity being supposed known, we get ϵ_1 and thence from the equation δ_1, which indicates the earth's rigidity. The only question is—are we certain of the ratio of the observed to the calculated tides?

[2] This suggestion has been made long ago.

made magnetic by induction from the earth's magnetism, it may be expected, in the northern hemisphere, to have its south-seeking pole uppermost, and, therefore, to attract everywhere the north-seeking pole. If, however, it be of greater horizontal extension, the effect of the lower surface may cause the vertical force on the north-seeking pole to be diminished near the edges. If it be self-magnetic, as are some lodestones, nothing of this kind can be predicated.

The Malvern Hills.—Observations on the declination and horizontal force show that, at Great Malvern, the disturbing attraction has a direction 126·6° W. of N., at Malvern Wells, 148·7° W. of N., but on the other side of the Hills, at Mathon, 97·8° E. of N., and at Colwell Green, 140·4° E. of N. It follows that these hills everywhere attract the north-seeking pole—and the disturbance is perceptible at distances of 1½ miles.

The Island of Canna, long noted as magnetic, is found to be highly so close to the basaltic columns, but the effect is scarcely at all perceptible at a distance of 200 yards.

South-East of England.—The declination curves here show an irregularity between Kew and Reading, and the isogonal of 18° 20′ makes a sharp S curve between Reading and Windsor. Calculating the disturbances thus indicated, a line of no disturbance is found to run north from near Chichester between Reading and Windsor and to the north of Oxford. A similar line drawn for no horizontal disturbance runs nearly east and west from Greenwich (with a curve at Kew), and cuts the former line between Reading and Windsor. A map of the vertical force disturbances gives an area of increased force, branching out in three directions, from near Reading, viz., towards Chichester, Cambridge, and Birmingham, and an area of still greater increase is enclosed in an inner curve. All these observations point to an underground mass of attracting rock, producing a magnetic "peak" near Reading, and branching out in the three directions above stated.

In the Wash, near King's Lynn, must be another centre of attraction, by the disturbances observed there in the declinations.

In Leicestershire, a line of low vertical forces, *i.e.*, negative disturbances, runs through Coalville, Leicester, and Kettering to Northampton, and the declination disturbances indicate that Charnwood is not a magnetic centre, the disturbance at Loughborough being away from it. The centre of attraction is near Melton Mowbray, where there must be an extremely steep peak forming part of a ridge from Chesterfield, through Nottingham, to Peterborough.

In the Highlands, there is a region of additional vertical force, with two branches from a point west of Mull; one up

the Caledonian Canal to Inverness and Elgin, the other up the west coast by Skye to Lewis. The former of these is also marked by a ridge line for the declination.

In the Lowlands, there are regions of increased vertical force on the east and west, and the independently-drawn declination ridge line runs along the valley towards the south side.

There may be a centre connected with the *Isle of Man and Cumberland*, and the convergence of the lines of equal horizontal force towards *North-west Wales* indicates a centre there.

In the *North-East of England*, the S-like curving of the isogonals, 19° 6′, 18° 48′, and 18° 16′, indicates an attractive ridge near Thirsk, between Hull and Gainsborough, and between Lincoln and Mablethorpe. The line thus indicated is confirmed by the coincidence along it of the ridge lines of both the declination and the horizontal force. It also traverses, towards the south, a region of increased vertical force.

In *Ireland*, as elsewhere, the horizontal forces tend towards regions of greatest vertical force; such are the basaltic rocks of Antrim, and the region of Connemara.

A magnetic map of the United Kingdom [fig. 1] gives a connected view of all these disturbances, and may be taken to indicate the underground range of basic rocks or other geological features which bring crystalline rocks nearer the surface. It is finally shown that the results are not due to changes in the earth currents.

***4. Rücker, A. W.—On the Relation between the Magnetic Permeability of Rocks and Regional Magnetic Disturbances.**

Proc. Roy. Soc., vol. xlviii., p. 505.

The disturbances in the magnetic forces which are recorded in No. **3**, can only be due to local earth currents, or to magnetic rocks below the surface. No connection can be traced with the former, and hence the present attempt to determine whether the latter is the cause. For this purpose, a determination has been made by **Mr. Highfield** and **Mr. Jarratt** of the magnetic susceptibility (κ) of a number of rock specimens. This was done by first determining κ—by the magnetometer method—for a series of standard magnetic fluids made by suspending magnetic oxide of iron in various proportions of glycerine. Tubes containing these fluids were successively brought to balance on a Hughes Induction Balance. A piece of the rock was then placed first in one fluid and then in another, between whose magnetic susceptibilities its own was intermediate, and its position between them fixed by the Balance. A number of

crystalline rocks from the Malvern ridge have thus been tested, but their localities given, *e.g.*, "near to the summit of the North Hill," do not guide very closely to their character, but their susceptibility is found to be closely proportional to the amount of magnetite present.

Specimens from the collection of J. W. Judd have also been examined, and the value of K × 100000 found to be:

Dolerite, Ratho	113	Olivine basalt, Tobermory	184
Enstatite andesite, Newport, Fife	59	Basalt, Tobermory Harbour	209
Enstatite andesite, Durham	134	Porphyritic basalt, Fishguard	61
Porphyritic basalt, Schemnitz	109	„ dolerite, Mull	155
Basalt, Faroe	116	Platy basalt, Mull	113
Olivine diabase, Nahe Rhine	47	Gabbro, Whaim Clackay, Mull	100
Basalt, Unkel on Rhine	45	Gabbro, Ben More	146
„ Rowley Regis	118	Basalt, Dumfruin	114
„ Giant's Causeway	27	Olivine gabbro, Ben More	429
„ „ „	21	Dolerite, Dun-da gaioth	156
Olivine, gabbro, Skye	697	Basalt, Staffa	48
„ „ Cuilin Hill, Skye	747	„ „	77
Fine-grained gabbro, Skye	246	Gabbro, Loch Coruiskh, Skye[1]	49
Olivine gabbro, Skye	553	„ „ „	164
Gabbro, Ardnamurchan	660	„ „ „	628
„ „	632	„ „ „	27
„ „	307	„ „ „	362
„ „	83	„ „ „	82
Dolerite, Tobermory	147	„ „ „	153
Porphyritic basalt, Tobermory	231	„ „ „	284
Olivine basalt, Tobermory	74	„ „ „	75
		„ „ „	684
		„ „ „	99

One of the best marked districts of vertical disturbance is a long band in Lincolnshire, &c., which may be taken as 180 miles long and 108 broad, bounded by narrower regions of negative disturbance. Such a distribution it is proposed to account for by the existence of underground masses of magnetic matter, and it is shown that if we assume the magnetism to be due to a rock of susceptibility=·0016 (the average of the Mull basic rocks), we can compare the observed increase of vertical magnetic force (in terms of ·00001 C.G.S. units) with the calculated if we assume a plateau 2½ miles from the surface for the main increase (140 obs., 159 calc.) and a mountain 1,640 ft. from the surface, or a peak 450 ft. from the surface for the special increases at particular localities (318 obs., 279 calc., and 464 obs., 510 calc.).[2]

[1] The great variations in samples of the same rock seem to point to accidental aggregations of magnetite.

[2] Or the susceptibilities of the rocks might locally vary, as they are shown to do above.

The assumptions made, however, in these calculations involve also an increase of the horizontal magnetic force considerably larger than any observed, so that some modification is necessary. If the calculated horizontal forces are made to agree with the observed, the vertical forces will be about one-third too small, but if the underground rocks were as permeable as those of Skye and Ardnamurchan all difficulty would vanish. The negative disturbance over a large area in Ireland may not be real, but due to the datum whence they are calculated being different in that country.

As to the Malvern Hills, the observed magnetic deflection can be accounted for, as far at least as the order of magnitude, by the attraction of its igneous rocks—if the latter extend not far below the surface for about a mile to the west.

The general result is that magnetic disturbances may be fairly considered due to underground magnetisable rocks.

***5. Rücker, A. W.—On a Possible Connection between the Ridge Lines of Magnetic Disturbance in England and France.**

"Nature," vol. xliii., p. 618.

From the magnetic survey of France, made by M. Mascart, "there appears to be good reason to believe that the ridge line which is thrown off from the Palæozoic axis at Reading crosses the Channel and is continued for 150 miles and for an unknown distance beyond into the heart of France." This depends on the fact that a ridge line is traced through Rambouillet, Elbeuf, and Fécamp, and at its most southerly point *i.e.*, Cosne, the disturbance is still great.

RECENT DEPOSITS.

6. Murray, John, and Renard, A. F.—Report on Deep-Sea Deposits, based on the Specimens Collected during the Voyage of H.M.S. "Challenger" in the years 1872-1876.

Report on the Scientific Results of the Voyage of H.M.S. "Challenger." Pp. xxix., 525; plates xxix.; charts 43; diagrams 22.

The Introduction gives the history of deep-sea exploration from the times of the ancients.

Chapter I.—On the various methods of obtaining, examining, and describing deep-sea deposits. The earliest portion is a *résumé* of the description given in a previous volume, and the remainder indicates how the material has been dealt with, with a list of the minerals obtained. It is practically repeated further on.

Chapter II.—On the nature and composition of the speci-

mens of deep-sea deposits collected during the "Challenger" expedition, and their variations with change of conditions. A table shows details regarding 498 different samples, viz., locality, depth, bottom and surface temperatures, designation and physical characters, percentage of, and organisms composing, the carbonate of lime, the nature of the residue with the character of its siliceous organisms, its minerals, and the fine washings, and additional observations on the sample. These materials serve as the basis for the later descriptions. Then follows a general summary of the character of the deposits along the various routes which the ship pursued.

Chapter III.—On recent marine formations, and the different types of deep-sea deposits; their composition, geographical and bathymetrical distribution. By "deep-sea" is meant anything below the 100-fathom line, which is found to be about the limit of the submarine continental plateaux. The deposits in this area are classed in two groups: I. Pelagic; II. Terrigenous. The physical conditions in the areas of the pelagic deposits are very uniform, the temperature range never exceeds 7° F., and the average is about the freezing-point of fresh water, and sunlight and vegetable life are absent. It has been impossible to recognise in the rocks of the continent formations identical with these pelagic deposits (the Radiolarian rocks of Scotland and Jamaica are called "doubtful exceptions"). They are classed as—

1. *Red Clay.*—This is regarded as principally derived from the decomposition of aluminous silicates and of volcanic eruptive rocks. Seventy samples have been examined from depths between 2,225 and 3,950 fathoms, the average being 2,730 fathoms. The amount of clayey matter is sometimes not very great, and the colour is most commonly red, but it is often dark chocolate, bluish, or grey. The upper layer is less dense than the lower, and often differs in chemical composition. It is by no means homogeneous, often containing fragments of pumice and minerals, and in one place a distinct layer of volcanic ash. The hydrated silicate of alumina never makes up more than half the mass. The amount of carbonate of lime decreases with the depth, being, on the average, 8·39 per cent. between 2,000 and 2,500 f., 7·16 per cent. between 2,500 and 3,000 f., and 0·88 per cent. between 3,000 and 3,500 fathoms. It mostly consists of fragments of foraminifera. The principal minerals are found in the fragments of pumice, and there are palagonite, basaltic glass and augite andesite, with peroxides of iron and manganese forming nodules, and black magnetic spherules of cosmic origin.

Off the West Coast of Africa are numerous dust

particles brought by the Harmattan wind. In the South Pacific and Indian Oceans phillipsite is a common decomposition product. In the Southern Ocean, and along the west side of the Atlantic, are many fragments of rocks dropped from icebergs. Fragments larger than ·05 mm. in diameter are comparatively rare, the mean is ·08 mm., and these make up on an average 5·56 per cent. of the whole mass. The following is the relative abundance of the mineral particles in the 70 samples: Magnetite 62, manganese grains 55, felspar 53, volcanic glass 45, augite 43, pumice 34, manganese nodules 32, hornblende 31, palagonite 22, quartz 21, plagioclase 20, mica 19, phillipsite, &c., 10, cosmic spherules 8, sanidine 7, scoriæ 6, glauconite 6, olivine 5, lapilli 5, rock fragments 5, zircon 3, tourmaline 3, epidote 2, garnet 1.

The average percentage composition is: Pelagic foraminifera 4·77, bottom-living ditto 0·59, other calcareous organisms 1.34, siliceous organisms 2·39, minerals 5·56, fine washings 85·35.

The chemical analyses by **J. S. Brazier** of 21 samples give the following results:—

	Max.	Min.	Mean.
Loss on ignition	10·40	2·20	6·17
Soluble in HCl			
SiO_2	32·60	11·03	23·55
Al_2O_3	12·91	2·15	7·64
Fe_2O_3	24·60	2·82	10·96
MnO_2	14·53	0·00	1·38
$CaCO_3$	60·29	0·92	14·23
$CaSO_4$	2·24	tr.	·67
$Ca_3\,2PO_4$	3·44	tr.	·66
$MgCO_3$	3·48	0·41	1·63
Insoluble in HCl			
SiO_2	37·70	9·43	23·40
Al_2O_3	11·37	1·60	5·82
Fe_2O_3	6·73	0·80	2·64
CaO	2·20	0·22	·83
MgO	0·95	0·09	·40

The alumina from the clay would be in the portion soluble in HCl, but would not compose the whole of it—thus the actual amount of "clay" must be rather small. The carbonate of magnesia is thought to come from incipient dolomitisation. The sulphate of lime is from the entangled seawater. The phosphate of lime indicates the fish bones, &c. The insoluble silica is derived from the mineral fragments.

The Red Clay is the most extensive of all the deposits, covering 51½ million square miles, of which nearly 41 millions are in the Pacific.

2. *Radiolarian Ooze.*—This only differs from the Red Clay in containing a greater abundance of siliceous organisms, varying from 80 (at the greatest depth) to 20 per cent. The organisms are chiefly radiolaria, but include also sponge

spicules, diatoms, and arenaceous foraminifera. Volcanic fragments and mineral particles are abundant, up to 5 per cent. Nine samples have been examined from depths between 2,350 and 4,475 fathoms, the average being 2,894 f. The average percentage composition is: Pelagic foraminifera 3·11, bottom-living ditto 0·11, other calcareous organisms 0·79, siliceous organisms 54·44, minerals 1·67, fine washings 39·88. The following two analyses are given:—

Loss	4·30	7·41
Soluble in HCl		
$Si\,O_2$	38·75	46·50
$Al_2\,O_3$	6·75	8·32
$Fe_2\,O_3$	11·20	14·24
$Mn\,O_2$	0·57	3·23
$Ca\,CO_3$	2·54	3·89
$Ca\,SO_4$	0·29	0·41
$Ca_3\,2\,PO_4$	0·65	1·39
$Mg\,CO_3$	2·46	1·50
Insoluble in HCl		
$Si\,O_2$	21·02	9·52
$Al_2\,O_3$	6·19	2·20
$Fe_2\,O_3$	0·39	0·75
$Ca\,O$	1·85	0·39
$Mg\,O$	0·34	1·25

This ooze occurs only in the Pacific and Indian Oceans, in the former occupying 1,161,000 square miles, and in the latter 1,129,000 square miles.

3. *Diatom Ooze.*—This is yellowish when wet, and white when dry. Five samples have been examined from depths between 600 and 1,975 fathoms, the average being 1,477 f. The recognisable diatom remains vary from 20 per cent. in the shallowest to 60 per cent. in the deepest spot. A list of 36 diatoms from a single station is given.

The carbonate of lime, mostly due to dead shells of pelagic foraminifera, varies from 2·00 per cent. in the deepest to 22·96 in the shallowest spot. The mineral particles are sometimes from ancient sedimentary rocks, and are probably brought by floating ice. The average percentage composition is: Pelagic foraminifera 18·21, bottom-living ditto 1.60, other calcareous organisms 3·15, siliceous organisms 41·00, minerals 15·60, fine washings 20·44. At the lowest depth were found 150 deep-sea animals. An analysis of the deposit here gives:—

Loss on ignition	5·30
Soluble in HCl	
$Si\,O_2$	67·92
$Al_2\,O_3$	0·55
$Fe_2\,O_3$	0·39
$Ca\,CO_3$	19·29
$Ca\,SO_4$	0·29
$Ca_3\,2\,PO_4$	0·41
$Mg\,CO_3$	1·13
Insoluble in HCl	4·72

The loss on ignition compared with the alumina indicates the presence of soluble silica. This ooze occupies 10,880,000 square miles south of 40° S. latitude and 40,000 square miles in the North Pacific.

4. *Globigerina Ooze.*—Only those samples are reckoned such that contain 30 per cent. of carbonate of lime. It is now settled that the foraminifera are surface species, of which a list of 21 is given. The colour is milky-white or rose-coloured far from land. The ooze is found in depths from 400 to 2,925 fathoms, the average depth being 2,002 fathoms. Other pelagic organisms are met with in the warmer seas, Coccoliths and Rhabdoliths, considered to be calcareous algæ, sometimes making up 15 per cent. The carbonate of lime ranges from 25 to 80 per cent., and decreases generally as the depth increases. One hundred and eighteen samples have been examined, all of which contained Globigerinidæ, 117 Pulvinulina, 116 Coccoliths, 114 Echinoderm fragments, 107 Rotalidæ, 105 Miliolidæ, 105 Rhabdoliths, 77 Lagenidæ, 71 Textularidæ, 64 Ostracods, 36 Pteropods, 33 Nummulinidæ, 28 downwards other organisms. The non-calcareous portion consists of 1 to 10 per cent. of siliceous organisms, chiefly radiolaria; 1 to 50 per cent. of minerals, of these, magnetite is present in 95 cases, felspars 86, augite 82, volcanic glass 63, hornblende 58, quartz 49, pumice 45, manganese 37, mica 31, plagioclase 24, sanidine 21, olivine 19, lapilli 18, glauconite 13, palagonite 10, and 11 other minerals 1 to 5 times; and from 9·60 to 47·73 per cent. of fine washings—increasing with the depth. Life appears to be much more abundant in these deposits than in the Red Clay or Radiolarian Ooze. The average percentage composition is: Pelagic foraminifera 53·10, bottom-living ditto 2·13, other calcareous organisms 9·24; siliceous organisms 1·64, minerals 3·33, fine washings 30·56.

Analyses of 21 samples by **J. S. Brazier** show the following:—

	Max.	Min.	Average.
Loss on ignition	9·60	1·00	4·97
Soluble in HCl			
SiO_2	16·90	1·36	7·21
Al_2O_3	19·24	0·65	3·61
Fe_2O_3	20·94	0·47	4·92
MnO_2	4·80	0·00	0·32
$CaCO_3$	93·14	37·51	66·60
$CaSO_4$	2·32	0·19	0·77
$Ca_3 2PO_4$	2·80	0·00	0·67
$MgCO_3$	2·58	0·19	1·12
Insoluble in HCl (variously determined)	26·71	0·93	9·81

The loss on ignition, not increasing with the carbonate of lime, must be partly due to hydrated minerals; but some is

due to the presence of an albuminous substance. Two analyses are also given of the residues after treating with HCl, which give silica 50·47—64·16, alumina 15·13—18·01, ferric oxide 8·19—12·75, manganese dioxide tr.—3·00, lime 1·66—1·71, potash, 1·01—1·11, soda 0·90—1·05, water 7·10—10·93. This shows that the inorganic portion of the ooze is analogous to the Red Clay. The soluble portion also yields silica 26·94, alumina 22·34, ferric oxide 50·72, which indicates a ferruginous clay. The area occupied by this ooze is 49,520,000 square miles, of which 22,500,000 are in the Atlantic, 12,220 in the Indian, and the rest in the Pacific. It passes up into the Arctic circle below the course of the gulf-stream waters.

5. *Pteropod Ooze.*—This occurs at depths between 390 and 1,525 fathoms—the average being 1,044 fathoms. It differs in character according to the proximity of land; at remote distances, the Pteropods and Heteropods may make up 30 per cent. of it. The carbonate of lime ranges from 52·22 to 98·47 per cent., and there are always present Globigerinidæ, Pulvinulina, and Coccoliths. The average percentage composition is: Pelagic foraminifera 47·15, bottom-living ditto 3·15, other calcareous organisms 28·95, siliceous organisms 2·89, minerals 2·85, fine washings 15·01.

Three analyses are given:

Loss on ignition	3·80	4·00	2·00
Soluble in HCl			
SiO_2	4·14	2·60	2·00
Al_2O_3	} 4·42	1·80	0·80
Fe_2O_3		3·00	3·06
$CaCO_3$	80·69	84·27	82·66
$CaSO_4$	0·41	1·00	0·73
$Ca_3\,2PO_4$	2·41	tr.	2·44
$MgCO_3$	0·68	1·28	0·76
Insoluble in HCl	3·45	2·05	3·90

These show that it differs from the Globigerina ooze chiefly in being more calcareous. It occurs only in the Atlantic, covering 400,000 square miles of the central ridge.

The Terrigenous Deep-Sea Deposits cover an area of 18,600,000 square miles, and are classed as—

1. *Blue Mud.*—This owes its colour to organic matter and sulphide of iron in a fine state of division, and it smells, when fresh, of sulphuretted hydrogen. The top layer is brown from the presence of ferric oxide, "but as the deposit accumulates, this oxide is transformed into sulphide and ferrous oxide in the presence of organic matter in the underlying layers." The carbonate of lime ranges up to 35 per cent. The depth of these deposits varies between 125 and 2,800 fathoms, the average being 1,411 fathoms. The organisms show a greater abundance of bottom-living foraminifera, and also some casts in glauconite. The mineral particles are derived from the

continental rocks, in some cases it is half made of these, the principal of which is quartz. The size of these decreases, and the amount of fine washings, increases with the depth.

Two analyses are given:—

Loss on ignition	4·92	5·60
Soluble in HCl		
SiO_2	23·52	28·20
Al_2O_3	7·75	5·50
Fe_2O_3	7·50	5·61
$CaCO_3$	1·75	2·94
$CaSO_4$	0·58	0·42
$Ca_3 2PO_4$	tr.	1·39
$MgCO_3$	1·14	0·76
Insoluble in HCl		
SiO_2	39·84	36·00
Al_2O_3	7·33	8·05
Fe_2O_3	3·73	2·77
CaO	1·63	2·51
MgO	0·31	0·25

The Blue Muds surround nearly all coasts and fill nearly all enclosed seas, even the Arctic Ocean, and cover 14,500,000 square miles.

2. *Red Mud.*—This occurs along the Brazilian coast, where it covers 100,000 square miles. It does not contain so much organic matter or sulphide of iron. Glauconitic casts and grains are entirely absent, and Diatoms and Radiolarians are almost wanting. The depth varies from 120 to 1,200 fathoms, the average being 423 fathoms. The carbonate of lime varies from 5·75 to 60·79 per cent., and is dependent on the nearness of rivers. The siliceous organisms are few, and mostly consist of sponge spicules. Quartz is the most abundant of the mineral particles, which, as before, become smaller at greater depths. The average percentage composition is: Pelagic foraminifera 13·44, bottom-living ditto 3·33, other calcareous organisms 15·51, siliceous organisms 1·00, minerals 21·11, fine washings 45·61. The following analysis is given: Loss on ignition 6·02, silica 31·66, alumina 9·21, ferric oxide 4·52, lime 25·68, magnesia 2·07, soda 1·63, potash 1·33, sulphuric anhydride 0·27, carbonic dioxide 17·13, chlorine 2·46 = 101·98. Part of the alkalies is due to entangled water. Similar red clays are found in the Yellow Sea.

3. *Green Muds and Sands.*—These are coloured by glauconitic grains and casts, and by amorphous green organic matter. They lie between 100 and 900 fathoms, off bold and exposed coasts far from river mouths. Wherever there is much ferric hydrate or river detritus glauconite tends to be absent, but it abounds where fragments of ancient rocks are long exposed to sea-water under the influence of organic matter The casts are reckoned as siliceous organisms. The mineral fragments are mostly angular quartz, orthoclase, plagioclase,

magnetite, hornblende, and augite are most abundant, and tourmaline, zircon, garnet, and fragments of continental rocks are characteristic. There are also small phosphatic concretions. The average percentage composition is: Pelagic foraminifera 14·59, bottom-living ditto 2·94, other calcareous organisms 7·99, siliceous organisms 13·67, minerals 27·11, fine washings 33·70. The green sands have a less quantity of amorphous matter; they are from shallower, more current-swept areas. Their composition is: Pelagic foraminifera 21·00, bottom-living ditto 15·00, other calcareous organisms 13·78, siliceous organisms 8·00, minerals 30·00, fine washings 12·22.

The following analyses are given[1]:—

	Green Mud.	Green Sand.
Loss on ignition	9·10	3·30
Soluble in HCl		
SiO_2	8·35	9·28
Al_2O_3	2·30	2·50
Fe_2O_3	4·70	12·30
$CaCO_3$	49·46	46·36
$CaSO_4$	1·07	0·58
$Ca_3\,2PO_4$	—	0·70
$MgCO_3$	2·02	0·57
Insoluble in HCl		
SiO_2	21·35	21·99
Al_2O_3	0·95	1·58
Fe_2O_3	0·35	0·42
CaO	0·22	0·30
MgO	0·13	0·12

The abundant carbonate of lime is from the pelagic organisms; the insoluble silica chiefly from the quartz. Green mud and sand occupy 850,000 square miles of the pelagic area off Portugal, east of North America, Cape of Good Hope, Australia, Japan, and South America, also off the coast of California and East Africa.

4. *Volcanic Muds and Sands.*—These occur chiefly round oceanic volcanic islands, between 260 and 2,800 fathoms, the average being 1,033 fathoms. The muds are brown or grey, and contain abundant volcanic fragments. The carbonate of lime average increases from 24·69 to 31·30 down to 2,000 fathoms, and then suddenly disappears. Glauconite grains are absent. The average percentage composition is: Pelagic foraminifera 10·50, bottom-living ditto 2·82, other calcareous organisms 17, siliceous organisms 1·82, minerals 40·82, fine washings 36·87.

The volcanic sands occur in current-swept areas, so that the fine mud is carried away, the residue being darker and

[1] These analyses add to 100, but the potash for the glauconite seems not to be included.

the mineral particles larger on the average. The average percentage composition is: Pelagic foraminifera 13·00, bottom-living ditto 3·80, other calcareous organisms 11·99, siliceous organisms 1·40, minerals 60·00, fine washings 9·81. The mineral fragments depend on the neighbouring volcanoes, the principal being sanidine, plagioclase, augite, hornblende, rhombic pyroxene, olivine, magnetite, generally glass-covered.

Three analyses are given:

	I.	II.	III.
Loss on ignition	4·94	6·30	6·22
Soluble in HCl			
SiO_2	10·76	11·71	16·22
Al_2O_3	5·91	5·71	5·00
$CaCO_3$	35·68	41·73	32·22
$CaCO_3$	1·05	1·15	0·27
$Ca_3 2 PO_4$	0·52	tr.	tr.
$MgCO_3$	2·04	1·43	0·83
Insoluble in HCl			
SiO_2	19·17	15·84	17·90
Al_2O_3	4·30	3·71	4·22
Fe_2O_3	5·38	3·43	3·77
CaO	2·58	1·43	1·44
MgO	0·65	0·72	0·22

"The alkalies have not been estimated."

These volcanic muds and sands occupy 600,000 square miles of the deep-sea area.

5. *Coral Muds and Sands.*—These occur round coral islands and reefs, between 140 and 1,820 fathoms, the average being 740 fathoms. The carbonate of lime ranges from 77·38 per cent. at 1,500 fathoms to 85·53 per cent. at 380 fathoms, and gives a white colour to the deposit, the residue being brown or reddish. The mineral particles are small, and generally of volcanic origin. Sponge spicules are always present, and the amount of fine washings increases with the depth. The average percentage composition of a coral mud is: Pelagic foraminifera 31·27, bottom-living ditto 14·64, other calcareous organisms 39·62, siliceous organisms 1·36, minerals 1·00, fine washings 12·11. The coral sand differs in having less fine material, and occurs in shallower current-swept areas of less than 300 fathoms, average 176. The average percentage composition is: Pelagic foraminifera 36·25, bottom-living ditto 20·00, other calcareous organisms 30·59, siliceous organisms 5·00, minerals 3·75, fine washings 4·41. An analysis shows lime 50·27, carbonic anhydride 42·28, magnesia 3·00, alumina, ferric oxide, and phosphoric anhydride 1·42. These deposits cover 2,556,800 square miles of the deep-sea area.

Chapter IV. *Materials of Organic Origin in Deep-Sea Deposits.*—The term "Benthos" is adopted from Haeckel for all the animals and plants which live on the bottom of the sea, and

these J. Murray divides into neritic and deep-sea benthos, the former he subdivides into littoral and shallow water, and the latter into bathybial for those living on the terrigenous deposits, and abyssal for those living on the pelagic. The term "Plankton" is also adopted from Hensen and Haeckel for animals living in the water above the bottom, those in mid-ocean being called oceanic, and those near land neritic (Νηριτες). The former are subdivided into pelagic for those within 100 fathoms from the surface, bathybial for those within 100 fathoms of the bottom, and the remainder zonary. The actual amounts of these are very variously distributed.

All the deep-sea deposits contain albuminoid organic matter, which is most abundant in the shallower parts, associated with sulphides. In the Blue muds, especially near the mouths of rivers, are numerous oval-shaped bodies, 0·5 m.m. in length, which are considered to be the excreta of Holothurians, &c.

The action of organic matter on the sea-water is as follows: The sulphates are decomposed by the decaying matter, each molecule yielding one of sulphide and two of carbonic acid. These react and form carbonates, giving off sulphuretted hydrogen, which becomes oxidised into sulphuric acid, decomposes the carbonates, and reproduces the sulphates. The nitrogenous portions produce ammoniacal salts, which are always present; these react on the sulphates and produce carbonate of lime—and this goes on at all depths, notwithstanding the pressure. [*See* No. **58**, 1890.]

The various well-known calcareous organisms are then briefly described.

The Coccospheres and Rhabdospheres are considered to be algæ. There are not more than 20 or 22 species of pelagic foraminifera, but a dozen of these equal in number those of all known species. The Gasteropods and Lamellibranchs are poorly represented in the abyssal regions, in which there is a wide difference between the oozes and the Cretaceous chalk. Fishes are represented by otoliths and teeth, and are more common in the Red Clay areas, particularly the shark's teeth. A list is then given of the localities and depths where fish teeth have been obtained. They comprise two in the Atlantic, one in the South Indian, and 13 in the Pacific Ocean. The greatest depth is 2,950 fathoms, and the largest tooth belongs to *Carcharodon megalodon*, 4in. long—both in the Pacific. The other genera represented are *Oxyrhina*, *Lamna*, *Corax*, *Otodus*? The mammalian remains consist chiefly of the earbones and beaks of Ziphioid whales, one being obtained from the Atlantic, two from the South Indian, and eight from the Pacific, principally from the Red Clay and Radiolarian areas. They are referred to the genera

Ziphius, *Mesoplodon*, *Delphinus*, *Globiocephalus*, *Kogia*, and *Balænoptera*. Fragments of these bones often form the centre of a manganese nodule, and the bones themselves are impregnated with manganous oxide, details of the analyses by **Dittmar** being given. When compared with recent and fossil bones, the fluorine (2·28 per cent.) is more abundant (against 0·032 and 1·50), owing, it is supposed, to a slow exchange between the phosphate of the bones and the fluorides of the water.

No cetacean remains were found north of the Equator.

The rate of accumulation of calcareous material is greater in the Tropics, owing to the more abundant surface-life. The absence of calcareous matter in the deeper deposits in the Tropics is accounted for by solution, the shells having farther to fall, and the solution being greatest under pressure, so that the water does not become saturated with carbonate of lime. Taking all the samples of Oozes, Red Clays, and Coral Muds together, there is a gradual decrease of carbonate of lime in each successive 500 fathoms, viz., 86·04, 66·86, 70·87, 69·55, 46·73, 17·36, 0·88, 0·00. The crystalline form of the material, whether arragonite or calcite, does not enter into the problem. It cannot be determined of which the shells are composed, but it appears to be of calcite—but they all equally disappear in the greater depths.

Some observations are then made on the siliceous organisms, and the question is raised, whence do they obtain their silex, sea water only holding in solution 1 in 250,000 parts, and it is suggested [*see* No. **15**] that it is obtained from suspended clay particles, of which ·0052 grams per litre have been found in mid-Atlantic water, and ·0066 in Mediterranean water. The suspension is easier in colder and fresher waters which is just where the Diatoms and Radiolarians abound.

Finally, it is noted that the rock called "white coral," said to have been dredged by the Tuscarora from 2,096, 935, 1,390 fathoms, and thus to prove the Darwinian theory of subsidence, has been examined, and turns out to be simply globigerina or pteropod ooze.

Chapter V. *Mineral Substances of Terrestrial and Extra-Terrestrial Origin in Deep-Sea Deposits.*—These are of three kinds, viz., derivative from the earth's crust, extra-terrestrial, and chemically formed *in situ*. The derivative group is obtained either from the continents or from volcanic eruptions. The latter principally characterise the pelagic areas. These volcanic eruptions are in many cases submarine—witness the new islands, conical mountains revealed by dredging, earthquakes with marine seismic centres, and aggregations of lapilli in certain spots. The most abundant material is

pumice, which disintegrates by impact on the surface, and, as is shown by experiment, slowly sinks in sea-water by becoming waterlogged. The principal variety is liparitic pumice; it is rich in silica, but quartz is very rare, and the individualised minerals are few, as sanidine, plagioclase, black mica, augite, and magnetite. The second variety is andesitic, in which the principal minerals are augite, plagioclase, and magnetite. An analysis of this gives silica 60·95, alumina 15·97, ferric oxide 9·08, lime 2·92, magnesia 1·40, potash 1·61, soda 2·34, loss 4·95. Both varieties are much decomposed. A third variety is basaltic pumice of bottle-green colour, with more spherical vesicles, and the minerals, olivine, augite, and plagioclase. Analysis: Water 1·70, silica 50·56, titanic acid 0·80, alumina 10·30, ferric oxide 4·92, ferrous oxide 7·59, manganous oxide 0·14, lime 9·35, magnesia 9·27, potash 1·24, soda 2·81, which resembles that of the lavas of Hawaii. Minute fragments of all these varieties can be recognised in the residues of most of the deposits.

Basic volcanic glass is common, though rare on the land; it occurs in moderately small fragments, often forming the centres of manganese nodules, or altered externally to palagonite. The latter is resinous-looking, yellow or brown. The glass is compact or scoriaceous, with perlitic fractures, sp. gr. 2·8—2·9, magnetic; attackable by acids. The palagonite is soft when fresh, minutely banded concentrically round the nucleus. These fragments are almost invariably coated with manganese, which is found also in the unaltered glass. They contain (in both parts) porphyritic crystals of olivine of various sizes, with tufts of trichites, and often enclosing some ground mass—also rhomboid plates of a plagioclase between labradorite and bytownite. Where the glass becomes vesicular, the decay goes on faster, and the fragment is only kept together by the manganese. The vesicles are coated with zeolite. Three analyses of the glass are given:—

	I.	II.	III.
SiO_2	46·76	49·97	46·84
Al_2O_3	17·71	11·68	17·78
Fe_2O_3	1·73	2·45	1·64
FeO	10·92	10·60	10·79
MnO	0·44	tr.	0·34
CaO	11·56	11·20	11·87
MgO	10·37	12·84	9·24
K_2O	0·17	0·25	0·28
Na_2O	1·83	1·60	2·02
P_2O_5	—	0·33	—
	101·49	100·92	100·80

and another of the palagonite, showing silica 44·73, alumina 16·26, ferric oxide 14·57, manganic oxide 2·89, lime 1·88, magnesia 2·23, potash 4·02, soda 4·50, water 9·56 = 100·64.

Palagonite tuff also occurs, consisting of angular fragments of palagonite with other minerals and volcanic fragments cemented together by zeolites, in some cases a phillipsite, and often enclosed in manganese. They have the essential characters of ashes. Their deposition may be as old as the Tertiary period; the thickness of the manganese coverings may indicate the length of time they have lain at the bottom.

Basaltic lapilli, less coated and more worn, are associated with these. They are felspathic and vitreous, generally fine-grained and vesicular, with zeolites. Fragments of limburgite are found with porphyritic augite and olivine; also of augite-andesite, with sanidine and quartz, and sometimes rhombic pyroxene, but acid rocks are especially rare, with the exception of the pumice. The volcanic ashes consists of minuter particles of the above, together with the results of the disintegration of the lapilli, and of the pumice, and of fragments brought by icebergs or wind. They are universally distributed, and, lying on the surface, cannot be of any great geological age. They are distinguished from the fragments of continental origin by a slight coating of glass or palagonite.

Fragments of continental rocks of any size, at great distances from land, and in great depths, have only been found in regions either within the limits to which icebergs float—both in the north and in the south, or to which they might have floated, if the ice at a former period had a somewhat greater extension. They are of all sizes, from several feet downwards, and are generally angular, and often glacially striated. It is noted also that seals and penguins swallow large stones, which would drop to the bottom if they died at sea. The following is a list of those observed: Between Bermuda and Halifax, syenite, diabase, quartziferous diabase, basalt, gneiss, mica schist, quartzite, dolomitic limestone; between Bermuda and Azores, micaceous sandstone, mica schist; between Tristan da Cunha and Cape of Good Hope, quartz, orthoclase, hornblende, tourmaline, and augite; between Heard Island and Melbourne, granite, granitite, gneiss, amphibolite, quartzite, micaceous sandstone, chloritic sandstone, red sandstone, and slates; between Tahiti and Valparaiso, granite and diabase.

The minerals derived from the disintegration of continental rocks are met with principally in the Terrigenous deposits, and, except on the track of icebergs, most abundantly nearest the land. Some are not known in volcanic rocks, and those which are so known are yet considered to be of continental origin from their association with the former. The principal

species found are hornblende, actinolite, glaucophane, apatite, calcite, chlorite, chromite, dolomite, orthoclase, microcline, plagioclase, garnet, glauconite, magnetite, white mica, sericite, olivine, bronzite, diallage, augite, quartz, rutile, serpentine, tourmaline, and zircon.

The mineral substances of extra-terrestrial origin consist of: (1) Black magnetic spherules [figs. 91, 92], seldom larger than 0·2 m.m. in diameter. They are perfectly spherical except for a circular depression on one side. Their outer coat is black magnetite, and within there is generally a nucleus of malleable metallic iron, which usually precipitates copper from its sulphate, and when this is not the case it may be schreibersite, or an alloy of iron, nickel, and cobalt, which two latter elements are found near these in the manganese nodules. The meteoric iron is believed to have been fused and oxidised in its passage through the air, and so to have preserved the interior from alteration, and the depression is due to contraction on cooling. (2) Brown-coloured spherules or chondres. These are less than a millimetre in diameter—average 0·5 m.m.; they are streaked by a lamellar structure, the lamellæ being arranged excentrically. Each plate presents two systems of crystalline lamellæ formed of little prisms cutting at 70°, each system extinguishing together at a maximum angle of 40°, with the long axis; they are, therefore, monoclinic. They have blackish-brown inclusions following the systems, and believed to be of titaniferous iron; the crystals themselves contain silica, magnesia, and iron. These spherules thus show all the peculiarities of the chondres of meteorites, except that the crystals of the latter are only known to be of the rhombic system. These brown spherules have not been found in any of the manganese nodules. Both kinds are relatively more abundant in the slowly-formed Red Clay.

Chapter VI. *Chemical Products formed* in situ *on the Floor of the Ocean.*—These consist of: I.—Clay.—This may be partly due to transport from the continents, as it has been shown that fine argillaceous particles will remain long suspended even in the most saline and warmest waters [*see* No. **15**], but part is due to the decomposition of aluminous silicates on the sea-floor itself, and in this case it is never quite pure.

II.—Manganese Nodules.—A detailed description is first given of the form and character of the nodules at numerous stations, from which it is seen that they assume a great variety of forms, and have nuclei of various kinds, as pumice, glass, tufa, rocks, corals, teeth, and earbones. Some have several nuclei and have grown together; one has been broken *in situ* and has received a fresh deposit. Internally the structure is concretionary. Those from a single spot have a general family

likeness by which they can be recognised. No crystallisation is seen, as the material is absolutely opaque, but a dendritic arrangement is discernible.

Forty analyses are given, which show as follows:—

	Max.	Min.	Average.
Loss on ignition	24·84	4·70	13·19
Soluble in HCl			
$Si\,O_2$	36·30	3·24	12·88
$Al_2\,O_3$	9·50	0·30	3·30
$Fe_2\,O_3$	45·00	5·86	21·52
$Mn\,O_2$	63·23	1·91	28·52
$Ca\,CO_3$	11·56	0·97	3·63
$Ca\,SO_4$	2·62	tr.	0·74
$Ca_3\,2\,PO_4$	53·12	0·00	1·77
$Mg\,CO_3$	4·92	0·14	2·09
Cu, Ni, Co O	0·79	tr.	tr.
Insoluble in HCl			
$Si\,O_2$	18·42	1·35	8·51
$Al_2\,O_3$	4·70	0·31	1·60
$Fe_2\,O_3$	5·04	0·60	1·37
Ca O	2·69	0·25	0·65
Mg O	0·52	tr.	0·23

Two other analyses are given to show the state of oxidation of the manganese. One by **Dittmar** gives 3·95 of oxygen to 19·39 of manganous oxide, which is a little under the 4·37 required to convert it in the mineral into $Mn\,O_2$; the other, by **Renard** gives 6·31 oxygen to 26·46 of manganous oxide, which is a little over the 5·96 required. On the other hand, in the appendix, another analysis by Dittmar of a special nodule show 3·77 and 3·90 (by different methods) of oxygen to 16·42 of manganous oxide, both of which are a little too much. **Dr. Gibson's** analyses (Appendix II.) gives 4·71 of oxygen to 21·46 of manganous oxide, which is less than the 5·00 required [there is no "excess" in this case]. On the whole, it is concluded that the manganese exists mostly as hydrated peroxide united with hydrated ferric oxide, and, partly, also (as suggested in the appendix) with ferrous oxide.

With regard to the source of the manganese, four opinions are stated; the first, originated and adopted by A. Murray, is that the material is derived from the decomposition of the volcanic rocks and minerals, by conversion into carbonate, and the subsequent oxidation of this [but the proportion of manganese present at any spot seems more than that in the still undecomposed rocks]. This view is not assented to by A. Renard, who considers the greater part must have been derived from the manganese in sea-water. Dieulafait found abundance in a residue of the water; but Murray and Irvine can detect none in the boiler deposits of ocean-going steamers. The second [*see* No. **12**] is that they have come from sulphate of manganese in sea-water, reduced by decaying organisms to

sulphide, and then oxidised. But Irvine and Gibson [*see* No. **14**] show that such a sulphide would be decomposed by the carbonic acid. The third is that the manganese is contained in submarine springs. The fourth is that the bicarbonates are changed at the surface into oxides, which are precipitated.

III.—Glauconite, except in the Tuscarora soundings off California, is never more than 50—60 per cent. of the whole. The grains rarely exceed 1 m.m. in diameter, and are associated with paler green and even pale grey casts. They occur in the chambers of foraminifera with a brown substance, into which in different chambers a transition may be traced. The growth breaks the shells, and after its separation the glauconite may continue to grow so as to become of an irregular form, but it does not form external casts. The material is homogeneous, showing aggregate polarisation; is sometimes dotted, but never zonary nor fibrous. These grains occur about the limit of the shallow water, where there is little river deposit, but much continental *débris*. It is absent from the pelagic deposits, except where similar *débris* is brought by floating ice, &c. It is remarkably absent in the Red Mud area, where the conditions appear identical. It is constantly accompanied by phosphate of lime. Four analyses are given of the material composed of dark green, light green, and grey casts:—

		I.	II.	III.	IV.
Pale casts ..	relative proportions	65	15	10	30
Pale green casts		20	35	25	40
Dark „ „		11	45	60	20
SiO_2 ..	.. ..	56·62	50·85	51·80	55·17
Al_2O_3 ..	.. ..	12·54	8·92	8·67	8·12
Fe_2O_3 ..	.. ..	15·63	24·40	24·21	21·59
FeO ..	.. ..	1·18	1·66	1.54	1·95
CaO ..	.. ..	1·69	1·26	1·27	1·34
MgO ..	.. ..	2·49	3·13	3·04	2·83
K_2O ..	.. ..	2·52	4·21	3·86	3·36
Na_2O ..	.. ..	0·90	0·25	0·25	0·27
H_2O ..	.. ..	6·84	5·55	5·68	5·76
		100·41	100·23	100·32	100·39

It is concluded that all glauconite grains originate in the cavities of calcareous organisms. The organic matter does not reduce the iron appreciably to the ferrous state. Very fine mud may penetrate through the foramina into the shells. "The organic matter enclosed in the shell and in the mud itself transforms the iron in the mud into sulphide, which may be oxidised into hydrate, sulphur being at the same time liberated, this sulphur would become oxidised into sulphuric acid, which would decompose the fine clay, setting free colloid

silica and hydrated oxide of iron in a condition most suitable for their combination," and "there is always a tendency for potash to accumulate in the hydrated silicate formed in this way," it being derived from the sea-water. At one spot, casts of foraminifera were found of a different nature to glauconite.

IV.—Phosphatic concretions were specially met with in 98 and 150 fathoms on the Agulhas Bank and in 1,900 fathoms 100 miles to the south-east. They vary from 1 to 6 c.m. in diameter, and are very irregular in form and rounded externally. Three analyses are given, one showing loss on ignition 4·10, silica 6·00, alumina 3·00, ferric oxide 5·80, manganese dioxide 2·70, carbonate of lime 16·07, sulphate of lime 2·62, phosphate of lime 49·57, carbonate of magnesia 0·98, insoluble residue 9·16. They enclose a large quantity of the surrounding material, whether green sand or globigerina ooze, which they cement. Purer phosphate penetrates the shells—and sometimes alters them. The bulk is concretionary in structure. These nodules are considered as derived from the decay of organic matter, and it is noted that they are abundant in localities where cold and warm currents meet, and which might thus destroy the animals.

V.—Crystals of phillipsite in marine deposits occur singly and loose in the pelagic deposits, where they occasionally make up 20—30 per cent. of the whole. The simplest forms are minute needles 0·027 m.m. by 0·005 m.m. of prismatic form—with faces oP, $\infty \breve{P} \infty$ at right angles, and terminated by a dome ∞ P of angle 120°. They belong to the monoclinic system. These may be twinned on the face oP, and also in a cruciform manner [fig. 93]. They are sometimes arranged radially with a centre and covering of manganese and iron. They also aggregate in spherulites 0·5 m.m. to 2 m.m. in diameter. The surface is made by dome faces, ∞ P, of the various radiating members which thin to a point towards the centre. Three analyses are given:—

	I.	II.	III.
Loss on ignition	7·59	7·35	9·47
SiO_2	47·60	49·88	48·70
Al_2O_3	17·09	16·52	17·58
Fe_2O_3	5·92	5·54	6·17
MnO	0·43	0·44	—
CaO	3·20	1·38	1·70
MgO	1·24	1·20	1·02
K_2O	4·81	5·10	4·83
Na_2O	4·08	4·59	3·75
H_2O	9·15	9·33	7·95
	101·11	101·33	101·17

The distribution of these crystals coincides with that of the basic volcanic glass and lapilli, and it is suggested that

actual lava flows may exist below the deposits where they are abundant. Like the zeolites of amygdaloids and of the Roman masonry at Plombieres, these are formed by the water leaching out the materials of the basic rocks, the remainder being argillaceous and like crystals of gypsum, or nodules of marcasite. They occur free in the soft mud. The material is not diffused generally, owing to the slow motion of the water. The low temperature, 2°—3° C., at which these must have been formed, shows that a high one is not necessary for the production of zeolites.

The appendices are as follows: I.—Explanation of charts and diagrams. II.—Analytical examination of manganese nodules, with special reference to the presence or absence of the rarer elements, by **John Gibson**. The following substances, not previously noticed, are recorded: Lithia trace, $(NH_4)_2O$, 0·02, strontia 0·02, baryta 0·12, cobalt oxide 0·28, nickel oxide 0·98, zinc oxide 0·10, thallium oxide 0·03, copper oxide 0·37, lead oxide 0·05, molybdenum trioxide 0·10, sulphuric anhydride 0·83, tellurium trace, chlorine 0·74, fluorine trace, phosphoric anhydride 0·13, vanadic anhydride 0·07, carbonic anhydride 0·29, titanium oxide 0·13. III.—Chemical analyses—already referred to and quoted—165 in all.

Plate i. is of the pumice fragments; ii.—iv. ix., manganese-iron nodules; v. and vi., shark's teeth; vii., viii., ear-bones; x., cetacean bones; xi.—xv., microscopic views of the various deposits; xvi.-xix., coloured sections of volcanic glass and palagonite; xx., phosphatic concretions; xxi., volcanic tufa in manganese; xxii. phillipsite; xxiii., cosmic spherules; xxiv., xxv., glauconitic and brown casts; xxvi., xxvii., mineral particles; xxviii., xxix., sections of manganese nodules. Chart I. gives the distribution of the various deposits [fig. 2]. The remainder show the course of the vessel. The diagrams are the previously-published temperature sections of the ocean.

7. Buchanan, J. Y.—On the Composition of some Deep-Sea Deposits from the Mediterranean.

Proc. Roy. Soc. Edinburgh, vol. xviii., p. 131.

Fifteen samples of mud dredged along a line from Marseilles to Algiers have been analysed. These show:—

	Max.	Min.	Mean.
Silica	44·37	14·79	34·33
Insoluble undetermined	23·96	5·44	13·37
Ferric oxide	6·64	3·45	5·17
Alumina	12·30	1·30	5·41
Calcium Carbonate	47·10	18·30	28·50
Loss on Ignition	10·89	2·90	4·72
Soluble undetermined	26·05	0·58	8·50

AQUEOUS AGENCIES.

8. Marten, H. J.—On some Water-worn and Pebble-worn Stones, taken from the Apron of the Holt Fleet Weir, on the River Severn.

Quart. Journ. Geol. Soc., vol. xlvii., p. 63.

This gives a definite numerical example of the abrading power of pebbles carried by a current. Six blocks of stone amongst many which formed part of the apron of a weir at Holt Fleet for forty-three years, viz., from 1844 to 1887, have been carefully examined after removal. They have been drilled through and through by the pebbles, which were carried up the steep slope and then down the apron by the river current. Photographs of these are shown. By weighing the portions left and calculating the original weight, it is found that there is a loss in the forty-three years of 47, 60, 48, 50, 37, and 58 per cent. respectively on the six stones. They are of soft red, non-calcareous sandstone, and were taken from part of the apron where the erosion was greatest.

***9. Reade, J. M.—Stalagmites of Sand.**

"The Naturalist" for 1891, p. 179.

A bed of peat, covered with a little sand, overhangs the sand on the shore: wherever drops of water, carrying a little sand, fall over on to the shore, a small pillar of sand is built up, sometimes largest at the top; this is kept up by the surface tension of the water, and when the sand below is saturated the pillar becomes supersaturated and drops. In the same way horse-hoof depressions on wet sands have been "corbeled" over by the horizontally blown sands, leaving a hollow below.

ORGANIC AND CHEMICAL AGENCIES.

***10. Davison, C.—On the Amount of Sand brought up by Lob-worms to the Surface.**

Geol. Mag., Dec. 3, vol. viii., p. 489.

The author has counted the number of castings of lob-worms on a given area on the sands near Holy Island—the average number of castings is 82,423 per acre; he has also weighed them, and finds that the average amount of sand brought up to the surface by lob-worms every year is 1,911 tons per acre. Thus "fresh sand is being continually introduced to the rounding action of the waves."[1]

11. Cornewall, Sir G. H.—The Formation of Travertine.

[1] The geological effect of this must be quite insignificant.

Woolhope Naturalists' Field Club, Aug. 28. (Printed in the "Hereford Times," Sept. 5.)

The author doubts the derivation of the name from "trans-tiburt-inus." He describes the formation in Depple Wood—whence the stone for Moccas Church was derived—by the growth of a moss, which causes the deposition round its roots, while it grows upwards, ultimately diverting the stream. The largest mass of travertine in England is Southstone Rock, near Stanford. He also mentions the case of Walker Mine, near Newcastle, where the thin deposit is discoloured during the day by the coal smut, but is clean at night, and the clean band is thicker every week on Sunday. Twenty weeks produce 4½ inches of travertine.

12. Buchanan, J. Y.—On the Occurrence of Sulphur in Marine Muds and Nodules, and its bearing on their Mode of Formation.

Proc. Roy. Soc. Edinburgh, vol. xviii., p. 17.

In the "Challenger" dredgings manganese nodules are constantly found associated with organic matter—and the same is the case with several dredgings off the west coast of Scotland. In several places, *e.g.*, off the Island of Arran, in the Sound of Jura, and also in the Gulf of Guinea off the Congo, and in the deep ocean waters, coprolitic mud in pellets is met with, which has passed through the bodies of worms or ophiuroids and contains sulphuretted hydrogen. Thus animals reduce sulphates to sulphides, which, acting on the triturated metallic silicates in the mud, produce sulphides of iron and manganese, and, by the later action of the oxygen in the water, these are transformed to oxides, with the separation of free sulphur. To test this supposed reaction, a number of samples of sea-bottom have been tested for sulphur, at first by treating with carbon bisulphide, a method afterwards abandoned as risky, then by boiling a weighed quantity in chloroform in a closed flask, evaporating the extract, and weighing the residue. This was then treated with hot nitric and hydrochloric acids and precipitated by barium chloride, and the sulphur determined from the barium sulphate produced.

The percentages of sulphur are very small—some examples are:—

Loch Fyne—Upper Basin	0·01	Globigerina Ooze	
,, Otter House	0·0009	(Atlantic)	0·0002
Loch Ness	0·00413	,, ,, (Pacific)	0·0004
Blue Mud ("Challenger")	0·0033	Manganese Nodule ..	0·000017
Diatomaceous Mud ..	0·0024	Red Clay, 2,600 fathoms	0·00067
Radiolarian Ooze ..	0·0031		

Some chemical details are then given, illustrating the above reactions.

***13. Irvine, R., and Anderson, W. S.—On the Action of Metallic (and other) Salts on Carbonate of Lime.**

Proc. Roy. Soc. Edinburgh, vol. xviii., p. 52.

Fragments of porous corals have been left for a long time immersed in metallic salts, with the following results:—

1. In a copper salt in 7 months 26·4 per cent. changed to carbonate of copper.
2. In manganese chloride in 12 months 58·4 per cent. changed to carbonate of manganese.
3. In salts of iron all changed first to carbonate then to sesquioxide of iron.
4. In salts of zinc in 6 months 26·8 per cent. changed to carbonate of zinc.
5. In phosphate of ammonia 60 per cent. became phosphate of lime.

The metallic salts form pseudomorphs, and show how shells may extract metals from the sea, and we learn also the possible origin of some phosphatic deposits.

***14. Irvine, R., and Gibson, J. — Manganese Deposits in Marine Muds.**

Proc. Roy. Soc. Edinburgh, vol. xviii., p. 54.

They discuss from a chemical point of view the theory of formation of manganese nodules propounded by J. Y. Buchanan [No. **12**]. They show that hydrated peroxide of manganese remains in solution in sea-water so long as there is any carbonic acid to take it up, that carbonate of manganese does slowly decompose and precipitate peroxide (Murray's theory), and that sulphide of manganese is quickly decomposed by carbonic acid, and in the presence of carbonate of lime and oxygenated sea-water is not peroxidised, but becomes a carbonate and the lime a sulphate. They cannot, therefore, agree with Buchanan's theory, and explain the cause of error by an experiment which shows that, while decomposing animal matter *does* reduce iron carbonate to sulphide, it does *not* so reduce the manganese carbonate.

15. Murray, J., and Irvine, R.—On Silica and Siliceous Remains of Organisms in Modern Seas.

Proc. Roy. Soc., Edinburgh, vol. xviii., p. 229.

Siliceous organisms are abundantly distributed in modern seas, but there are no soluble silicates from which to derive the material, as is the case with the calcareous. Estimations of the amount of soluble silica itself in sea-water differ considerably, probably owing to the difficulty of separating the finely-suspended matter, but the average of the minimum results show that there is not more than 1 part in 250,000 or 500,000, and this is not considered to be sufficient for the purpose. It has been found also that silicates, *e.g.*, of

magnesia, are not absolutely insoluble, but are less so in fresh than in sea-water. Rivers are, therefore, not likely to contribute such silicates. The silica actually determined in river-water is about equal to that in the sea. The authors have, therefore, been led to look to the suspended particles of clayey matter for the source of the silica. They show, in the first place, that some clay is actually held in suspension for at least 120 hours even in the clearest water, and under most unfavourable circumstances, to the amount of 0·0003 grammes per litre, but that the amount increases with the lowering of the temperature and salinity. The last point does not come out very clearly from the tables, or at least it is only below a salinity of 1010 that any increase appears. In actual sea-waters far from land, they have found, in Firth of Forth, 0·00185 grammes per litre, in the Atlantic 0·00037, in the German Ocean 0·00045, in the Mediterranean 0·00046, in the Baltic (salinity 1005·5) 0.00075, in the Red Sea 0·00004, and in the Indian Ocean 0·0004. They point out that this amount is from $\frac{1}{4}$ to $\frac{1}{18}$ that of the soluble silica. They point out, however, that Diatoms and Radiolaria are most abundant where the water is coolest and freshest. They have also tried the direct experiment of growing Diatoms in water, and find that unless they are supplied with silica in some form they cannot thrive, but that they flourish with gelatinous silica, suspended clay, or silicate of lime, but not with amorphous silica. The principal arguments in favour of the suspended particles being the source of the silica are that the distribution of the organisms is thus accounted for, and that if the soluble silica were used they would have to take in too much water.[1]

ERODING AGENCIES.

*16. Reid, A. S.—Sandpipes.

"The South-Eastern Naturalist," vol. i., p. 43.

Abstract of paper on the general subject and on the Lenham pipes in particular.

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[1] These arguments can scarcely be regarded as conclusive. In one place the authors say "that the amount of soluble silica is so minute that it is difficult to believe it to be the exclusive source from which the Diatoms and Radiolaria produce the silica"—yet the suspended particles may amount to only $\frac{1}{4}$–$\frac{1}{18}$ as much—and elsewhere we read, "in either case," *i.e.*, whether it be soluble silica or suspended clay, "without doubt the amount found is sufficient to account for the growth and accumulation of siliceous organisms in modern seas." Silica in solution is also a more constant source, whereas only one particle of clay is to be met with out of six or more million parts of water. Moreover, the diatom ooze occurs where there is least likely to be any source of the clay particles.

17. Day, A. E.—Funnel Holes on Lebanon.

Geol. Mag., Dec. 3, vol. viii., p. 91.

The author cites these as illustrations of the power of chemical solution unsupplemented by the action of torrents. The mountains are worn into deep gorges in their lower parts, but above 5,000 ft. all signs of mechanical action cease, and the summits are broad and rounded. It is here that, in secluded spots, snow lasts nearly all the summer, and at the foot of every such mass of snow are deep, straight-sided funnels, a few feet to 100 yards across—coming to a point at the bottom, which can only be due to the solution by the melted snow of the compact limestones which forms the summits.

18. Bourne, E. G.—Recession of the Niagara Gorge.

"Nature," vol. xliii., p. 515.

The "Journal of William Maclay" has in 1790 an estimate of the rate of erosion before that time, which, on the authority of "people who have known the place," was 20 ft. in 30 years, from which he calculates that the gorge has taken 55,440 years to cut, a much longer estimate than the modern ones, and remarkable for the time of its production.

GLACIAL AGENCIES.

19. McConnel, J. C.—On the Plasticity of an Ice Crystal.

Proc. Roy. Soc., vol. xlix., p. 323.

By experiments on bars of ice cut in different directions with regard to the optic axis of the crystal, and subjected to pressure below the melting temperature, it is found that the bending of ice into new shapes takes place within the individual crystals, by the shearing of one layer over the next. These layers are necessarily perpendicular to the optic axis, for the bar will not bend in the perpendicular plane. Long bubbles in ice remain parallel to each other, even when the bar is bent.

20. Howorth, H. H.—The History and Present Position of the Theory of Glacier Motion.

Mem. and Proc. Manchester Lit. and Phil. Soc., vol. iv., pp. 69–151.

Intended to be "as complete a monograph as possible," from a historical point of view. Above a certain line, higher than the snow line, the snow only melts superficially, and does not compact into ice,[1] but below this a granular structure

[1] *Cf.* Nansen's account of Greenland snow.

is produced by the agglomeration of crystals, irregularly arranged, and larger as the glacier goes further down, and in this respect a glacier differs from ordinary ice.

There have been two groups of theories to account for glacier motion; the first more or less excludes gravity as a factor, and appeals to the action of heat. The earliest form was that which supposed the water to find its way into cracks and crevices, and, on freezing, to force the ice downwards. This is called the dilatation theory, and is said to be disproved by its disregard of the latent heat of ice, by the motion of the ice in winter, by the small amount of night freezing which actually takes place, and the absence of the supposed capillaries. This was modified by appealing to the growth in size of glacier crystals at the bottom. To this it is replied that it would require a temperature of $-7°$ F., that there is no force to re-open the fissures, and that the glacier ought also to swell upwards. The theory of dilatation in solid ice by variations of temperature will not account for the motion in summer; and the range of temperature required for a certain amount of dilatation would be $9\frac{1}{2}°$ F., nor would the heat actually reach the interior. The melting of ice by pressure requires more pressure than there is. The notion of internal melting of molecules is altogether contrary to physics, and requires that the glacier should always be at 32°. All of these theories also leave untouched the differential motion of glaciers.

The theories that call in gravity are, first, that a glacier slips as a solid. In this case it would move faster, and could not, as in some cases, rest at angles of 20°—30°. It is admitted to be proved that the sliding due to gravitation is an important element, but that a glacier does not move *en masse* is shown by the differential motion. The hydrostatic pressure theory is disproved by the motion being continuous, and the same fact is fatal to the idea of the ice being divided into longitudinal strips moving at different rates. The view adopted is that of Forbes—that ice moves as a plastic body, by which the differential motion, the various forms assumed at different parts, and the banded structure is explained. The greater plasticity near the melting point shows the reason of the greater motion in summer. The experiments which were said to show that the shearing force required for this was too great, omitted the element of time; when the shearing is slow, less force is required than that which may act on glacier ice. The regelation theory involves that the ice cannot move when below 32°—but it does do so; not is there any sign of the ice being broken. The conclusion is, "that the motion is

that of a slightly viscous mass, partly sliding on its bed, partly shearing upon itself under the influence of gravity,"—"this effectually disposes of the theories of great ice sheets."[1]

***21. Jamieson, T. F.—The Scandinavian Glacier, and some Inferences derived from it.**

Geol. Mag., Dec. 3, vol. viii., p. 387.

The author calls to mind that it was Charpentier who, fifty years ago, referred the boulders of Saxony and Prussia to a Scandinavian ice-sheet. By tracing the limits of these blocks in the S.E. direction to the government of Kiew, and to the north of the Carpathians, the author shows that the ice must have travelled 1,000 miles from its highest source. He then goes to Greenland, to enquire the average fall per mile of the surface at which such a mass of ice could move—the Alps being no guide, as the slope of their glaciers is about six times as great. The observations of Nordenskiold give 72½ ft. per mile, those of Dr. Hayes give 71 ft., those of R. E. Peary, 75 ft. Those of Nansen are the most complete, as he crossed from shore to shore, a distance of 340 miles, reaching an altitude of 8,500 ft. in the centre; this gives 50 ft. per mile—but the surface of the ice is dome-like, and the slope is greater near the coasts. If, then, we allow 60 ft. per mile for the marginal 100 miles, and only 12 ft. per mile for the 900 interior miles, the height of the Scandinavian centre of dispersion must have been 16,800 ft. Its present culminating point is 8,544 ft. Hence, at the Glacial Epoch it must have been much higher than now. This conclusion is confirmed by the depth of the submerged fiords, the deepest of which, the Sogne Fiord, is 4,080 ft., and by the necessity for lofty mountains as condensers of the vapour. He suggests that the accumulation of the ice may have brought about depression by its weight, and the subsequent elevation is the recovery from this after the ice was removed. The depression may have originated before the Glacial Epoch, and the consequent lateral pressure may have originated disturbance of the strata in the South of England, as well as the volcanic outbursts of Germany and the Auvergnes.[2]

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[1] This last statement is, perhaps, the main point in the author's mind; but its connection with the paper is not shown, and a glacier is not an ice sheet. Two distinct matters require explanation: How a glacier moves? and, What makes it move as it does? The first conclusion, as stated, may be perfectly accepted; and yet we may ask, do not refreezing of the water, variations of temperature, growth of crystals, regelation, and lowering of freezing point under pressure all assist gravity to make it move as it does?

[2] It is not very clear in these calculations whether we are dealing with the top of the ice or with the summits on which it rests—if the latter, the estimates would involve an alarming rise of land; if the former, how were the boulders carried? None were seen in the middle of Greenland.

***22. Goodchild, J. G.—The Motion of Land Ice.**

Geol. Mag., Dec. 3, vol. viii., p. 19.

Attention is called to the contraction of ice on lowering the temperature, as set forth in Brunner's paper quoted by Prestwich, and to the limited conducting power of ice preventing the heat escaping from more than a certain depth. When the surface is much chilled below the freezing point it will crack, and form crevasses, which are limited downwards; into these water will flow, and on freezing will expand and force the ice downwards.[1] The point of the paper, however, is to show how *terrestrial radiation* makes the part nearest the rock move fastest. When a whole valley is filled with ice, the isogeotherms, instead of nearly following the contour of the valley, will rise to a higher level and run through the ice itself, which will be thus of a higher temperature than the surface, and, expanding more, will move more in the direction of least resistance.[2] The author then says: "The movement of a thick mass of ice under enormous pressure must result in the conversion of part of the force so exerted into heat," thus aiding the expansion and resulting motion of the parts next the rock.[3]

23. Sherwood, Wm.—Mud Glaciers of Cromer.

"Nature," vol. xliii., p. 515.

The mud over the Boulder Clay flows out on the sands in the form of mud glaciers. These show the usual longitudinal crevasses in the process of fanning out, and generally the similarity to an ice-glacier is close. The inference appears to be that the special nature of ice is unnecessary to account for its motion.

***24. Irving, A.—Motion of Land Ice.**

Geol. Mag., Dec. 3, vol. viii., p. 141.

Points out, in reference to No. **22**, that shrinkage cracks would close up again when the temperature rises; asks what becomes of the latent heat; objects to the phrase "cold waves"; says that the theory of the rise of the isogeotherms could only apply when rocks and ice were much below freezing point, and indicates other objections.

25. Lewkowitsch, J.—The Physical Properties of Ice and Glaciers.

Trans. Leeds Geol. Assoc., part vi., p. 21.

An elementary account of the well-known properties.

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[1] Agassiz's old abandoned theory, see No. **20**.

[2] This assumes that the lower part of the ice is below the zone of invariable temperature, in which case there will be no motion at all, except secular, since motion implies change.

[3] The loss of motion which is converted into heat cannot produce more motion than is lost.

26. Dickson, E., and Clay, W. G.—Observations on Moraines and Glacial Streams in the Valley of the Rhone and near Grindelwald.

Proc. Liv. Geol. Soc., vol. vi., p. 259.

At the end of the upper glacier of Grindelwald the under surface of the ice was covered with small angular fragments of mica schist, the floor of Jurassic limestone being covered with the same; the sediment was the same material more ground up. The material from the lower glacier was similar, but finer. Further down, the deposit is darker and finer, but is not a "clay"; nor is the deposit from any of the streams which feed the Rhone. He concludes, though with some hesitation, that the character of the deposits depends more on what is brought on to the glacier than to its bed. He has never seen any deposit from any glacial stream that in any way resembles a clay.

He has also examined the ground from which the upper glacier has lately retreated, and found the recent moraines very irregular, but he could not obtain a single scratched stone; all the stones below a certain line were rounded, above this, there were angular ones, but none were cemented. Scratched stones, however, occurred in some of the terraces. One of these terraces, representing a lateral moraine was also cemented by the fine sandy material. Underneath the glacier there was no evidence of "churning," the surface was not entirely smoothed. Somewhat similar was the result of his examination of the lower glacier. He could find no example of excavation, the glacier seemed to go round rather than surmount an obstacle.

The second author discusses the theoretical aspect of the question. The glacier receives heat from (1) the compression of the snow into ice; (2) the fall of the ice down the slopes; (3) the internal heat of the earth. This latter he *assumes* will keep the bottom of the glacier at 32° F., while the ice above this *may* decrease at the same rate as the earth does. He points out that when the ice meets an obstacle, the increased pressure on the upper side will cause it to melt and pass by—so it is a poor denuding agent except for its stones. Its energy of position is not used in eroding but in heating it.

27. Holland, P., and Dickson, E.—Examination of the Glacial Waters and Deposits from the Rhone Valley and near Grindelwald, and of Glacial Waters from near Chamounis.

Proc. Liverpool Geol. Soc., vol. vi., p. 322.

The object is to ascertain the nature of the material that is carried by water issuing from the end of a glacier. First

is given the number of grains per gallon of (A) insoluble, (B) soluble matter, (C) course sand.

		A.	B.	C.
Arveiron (Aug., 1888)	..	14·2	4·18	
" (July, 1890)	..	17·97	1·54	13·64
" "	..	16·38		14·91
Rhone (Mar., 1890)	..	6·62	23·73	
Lower Lutschine (Mar., 1890)		6·58	16·24	
Mer de Glace (July, 1890)	..	25·20	1·05	22·05
" "	..	24·80		21·75

The soluble matter consists principally of sulphate and carbonate of lime, with very little chloride of sodium. The suspended matter is finer the further from the glacier.

Analyses are then given of (A) the fine sandy material at the edge of Arveiron; (B) the sandy material of the Rhone Delta in the Lake of Geneva; (C) the clay separated from the same.

	A.	B.	C.
SiO_2	80·82	61·97	49·37
Al_2O_3	10·26	11·82	20·64
Fe_2O_3	1·34	5·52	6·71
MnO	—	·32	—
TiO_2	—	·21	—
CaO	—	8·12	8·45
MgO	—	2·19	3·47
CO_2	—	3·70	4·27
K_2O	—	2·17	—
Na_2O	—	2·44	—

These do not indicate a true clay, and on drying, the mud is seen to consist largely of very fine micaceous sand, and the lime and magnesia are partly combined as silicates.

The hard material produced by the kneading action of the glacier consists of:—

Sand and Felspar	48·73
Silica uncombined	4·87
Silicate of Alumina	8·48
Carbonate of Lime	34·11
" of Magnesia	2·37

which also does not represent a clay.

VOLCANIC AGENCIES.

28. Hart, T.—Notes on Volcanic Paroxysmal Explosions, and the Causes of Volcanic Action.

Geol. Mag., Dec. 3, vol. viii., p. 121. Rep. B.A. for 1890, p. 825.

He suggests that the impetuosity of the upward current in a volcanic vent during eruption acts as a self-acting injector, and draws in the water from the neighbouring cracks, to which it may partly have access by the

preceding earthquakes; also that the water dissociated at great depths by the heat may itself provide fuel.

29. Johnston-Lavis, H. J.—Report of the Committee appointed for the Investigation of the Volcanic Phenomena of Vesuvius and its Neighbourhood.

Rep. Brit. Assoc. for 1890, p. 397.

Various observations are here recorded on several points. An account is given of the variations in the state of Vesuvius from time to time between May, 1889, and August, 1890. The Funicular railway of Monte Santo has shown thin beds of pumice and dust below the pipernoid tuffs, which may be the oldest volcanic products of the Phlegræan Fields. A similar succession is seen at Puccianello, from which he concludes that these belong to the same widespread eruption, and that the latter is not a mere local one. Some of these lower beds contain fluorine, and the limestone below is eroded. This must have been brought by water percolating through the pipernoid tuff.

He has been able to trace the raised marine terrace at Castellamare, and refers it to the same period as the erosion of Monte Barbaro, and the deposit of shells in the cliffs. Ejected stones, one weighing 7½ ounces, are found on the top of the island of Capri—showing the distance to which they may be thrown.

A new section is described in the tuff quarries of Fajano, showing beds belonging to five distinct "Phases" of Vesuvian eruption.

A description is then given of what has been met with, and what may yet be expected in the course of the main-sewer works. The Neapolitan tuff is found to have a thickness of 80 metres, and, if due to a single eruption, this must have been a great one. A section is shown across Mt. Olibano and Solfatara, passing through two necks of trachyte. It also passes through the region where the land has been raised, and it appears that the height of the sea, at the period of one of the eruptions, is shown by the colour of the tuff, which is reddened by the hot blocks which fell into it on the land, but not reddened in the lower portion, which was below the sea, as the blocks would be cooled in the water. The remainder deals with the possible temperature, deleterious vapours, and thermal waters, which may be expected, and discusses whether the changes of level, which are still in progress, will, in the end, destroy the works.

30. Johnston-Lavis, H. J.—The Eruption of Vesuvius of June 7, 1891.

"Nature," vol. xliv., pp. 160 and 320.

A fissure was seen to gradually open during seven hours

from near the summit to the Atrio del Cavallo, when a black smoke arose. Lava also poured out to a slight extent, while the edges of the central crater were falling in.

The lava on June 15 was continuing to dribble, and produced fumaroles, whose vapours deposited stalactites of various chlorides. The lava is vitreous and coarse-grained from its leucite crystals, and ropy. This is because it has been simmering since January, and has let off all its water. From the radial rift, when cooler, were collected fine masses of molysite and kremersite.

*31. **Butler, G. W.**—The October Eruption North-West of Pantallaria.

"Nature," vol. xlv., p. 154.

There was no "island," but a narrow band of floating bombs for about a kilometre N.E. and S.W. probably indicated the submarine fissure. These bombs soon sank.

32. **Anderson, T., & Johnston-Lavis, H. J.**—The supposed Volcanic Eruption on Cape Reykjanaes.

Rep. Brit. Assoc. for 1890, p. 810.

A new Giá, or chasm, was said to have been produced in 1887 in Cape Reykjanaes, Iceland. The authors consider Giás, especially the Allmana Giá, to be formed by unequal settling of a crust of lava resting on a still fluid mass, which obtains an outlet at a lower level. In the present case, however, no such sinking has occurred, the beds of ash being at the same height on both sides; it is only the ordinary foundering of a cliff, due possibly to one of the numerous earthquakes which affect the district.

33. **Carter, W. L.**—The Life-History of a Volcano.

Trans. Leeds Geol. Assoc., part vi., p. 65.

A general description following the lines of Judd's "Volcanoes."

34. **Fulcher, L. W.**—Vulcano and Stromboli.

Proc. London Amateur Sc. Soc., vol. i., p. 46.

Gives a short account of the most recent eruption of each, and of the visit of the members of the Geologists' Association.

35. **Thomas, T. H.**—A Visit to the Lipari Isles and Etna.

Rep. and Trans. Cardiff Nat. Soc., vol. xxii., p. 11.

A personal narrative of the trip with the Geologists' Association.

36. **Eunson, G. S.**—Stromboli and Vulcano.

Journ. Northampton Nat. Soc., vol. vi., p. 113.

A similar account.

EARTHQUAKE PHENOMENA.

*37. Davison, C.—On the British Earthquakes of 1889.

Geol. Mag., Dec. 3, vol. viii., pp. 57, 306, 364, plate x. Abstract in Proc. Roy. Soc., vol. xlviii., p. 275.

The author records the intensity of the earthquakes observed by means of the "Rossi-Forel" scale, which, though dating from 1873, it may be useful to transcribe:—

I. Recorded by a single seismograph, or by some seismographs of the same model, but not by several seismographs of different kinds; the shock felt by an experienced observer.
II. Recorded by seismographs of different kinds; felt by a small number of persons at rest.
III. Felt by several persons at rest; strong enough for the duration or the direction to be appreciable.
IV. Felt by persons in motion; disturbance of movable objects, doors, windows, cracking of ceilings.
V. Felt generally by everyone; disturbance of furniture and beds, ringing of some bells.
VI. General awakening of those asleep, general ringing of bells, oscillation of chandeliers, stopping of clocks, visible disturbance of trees and shrubs. Some startled persons leave their dwellings.
VII. Overthrow of movable objects, fall of plaster, ringing of church bells, general panic, without damage to buildings.
VIII. Fall of chimneys, cracks in the walls of buildings.
IX. Partial or total destruction of some buildings.
X. Great disasters, ruins, disturbance of strata, fissures in the earth's crust, rock falls from mountains.

He takes as the epicentrum, or projection of the seismic focus on the earth's surface, the centre of the elliptical isoseismal lines, and only those earthquakes are reckoned as British whose epicentra fall within the islands. The following are the five observed during the year.

I. Edinburgh, Jan. 18, 1889.—The first shock had an intensity of v. or more. The second shock was of intensity vi., epicentrum 3 miles W. 42° S. of Balerno. The disturbed area extended about 30 miles N. and S. and 26½ miles E. and W., but was not felt on the Castle or Calton Hills.

In all cases but one the oscillation was a rise followed by a fall. All of these were in the northern part, and the exception was to the east of the epicentrum. The whole did not last above three seconds. The observed earthquake sounds were not co-extensive with the disturbed area, and the centre of them was 2½ miles S. or S.E. of the epicentrum. He notes that the most important faults of the district are three, which run parallel to the general strike of the rocks and along the axis of the Pentlands. The largest, to the S.E., has a downthrow to the S.E., the other two to the N.W. The second is 2½ miles from the epicentrum, but is

on the S.E. side of both it and the sound-centre. He therefore concludes that the earthquake is connected with this fault. The hade of this fault is not exactly known; but if it be estimated at 15°, the seismic focus, supposed to lie on it, would be about 8¾ miles below the epicentrum. The order of the motions felt [*see* No. **38**] indicates that the downthrow of the fault on the N.W. side was increased—the maximum slip being at the focus, but the sounds proceeded from the upper part of the fault.

II. Lancashire earthquake, Feb. 10, 1889.—Intensity vi., epicentrum about 2 miles N.N.E. of Bolton. The disturbed area was 56 miles from N. to S., and 54 miles from W. to E. The time records are too discordant to lead to any results as to the rate of propagation. The shock is described as a rumbling followed by a thud, as of a falling body. At other places, double or treble vibrations were felt, and an attempt is made to connect these with the direction of the Irwell fault. At four places a sudden rise was followed by a fall, and these lie only a few miles N.E. of the Irwell fault, which runs N.W. and S.E. The intensity has been determined by newspaper accounts, and an isoseismal of v. is drawn on the map. The sounds were only heard within a circular area 29 miles in diameter, and centre about 3½ miles S.S.E. of the epicentrum. In five places they are recorded as sudden, and in thirteen as prolonged; but the positions of these five places on the map do not lead to any conclusions. It is thought that, "on the whole, the duration of the sound was greater at places near the line of the Irwell fault." The earthquake was also felt in mines, but did not affect the magnetic instruments at Stonyhurst. It is considered that the earthquake was due to a slip of the Irwell fault, though the centre of the sound phenomena lies on the opposite side of this to the epicentrum. The slip was a downthrow on the N.E. side, and therefore increased the throw. The hade of this fault being 28°, the seismic focus was probably 3¾ miles down. The circular form of the isoseismals shows that the slip was short, in a horizontal direction.

From different parts of the slipping area vibrations of different amplitude and different period will arise—those only with short periods, which will be produced on the margin of the area, will result in sounds, and thence the sound-centre comes nearer the surface where the slip is dying away.

III. Ben Nevis earthquake, May 22, 1889.—Intensity iv., only noticed at the observatory, and another earthquake of small intensity was observed at Invergarry.

IV. Kintyre earthquake, July 15, 1889.—Intensity v., epicentrum at 3½ miles S.E. of Clachan. The disturbed area was elliptical, 25 miles from N. 30° E. to S. 30° W., by

18 miles. It was a single vibration of two or three seconds, accompanied by sounds. No fault is traceable in the neighbourhood, but the longer axis is parallel to the direction of the possible slipping of the gneiss infolded with the slates.

V. East Cornwall earthquake, October 7, 1889.—Intensity iv., epicentrum 2½ miles S.W. of Altarnon. The disturbed area is elliptical, 25 miles from E. to W., by 20 miles N. to S. The intensity was very uniformly distributed, indicating a deep-seated focus; the sounds everywhere accompanied the shocks, but were less noticeable near the margin, indicating less depth for the sound focus. The earthquake lasted up to 20 seconds, proving a large focus. The epicentrum is in the centre of the East Cornwall granite mass, and the folding of the rocks is parallel to the long axis of disturbance. Two other doubtful earthquakes are also mentioned, viz., at Little Rhondda Valley, June 22, and Lyme Regis, July 5.

These earthquakes illustrate the dying away of the forces which produce faults and belong to "the epoch immediately preceding the death of a mountain chain."

***38. Davison, C.—On the Inverness Earthquakes of November 15 to December 14, 1890.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 618.

Two "principal" and nine "accessory" shocks are recorded, one on November 15. Epicentrum, 4½ miles S. 21° E. of Inverness. The intensity on the Rossi-Forel scale [*see* No. **37**] was at most 7, and two isoseismals of intensities 4 and 5 are drawn on the map. The former encloses an oval area 86½ miles by 61½ miles, the longer axis lying N. 52° E. The latter is nearly parallel, but approaches the other on the S.E. side. The other principal shock was on December 14, its epicentrum being 4 miles S. 34° W. of Inverness, and the disturbed area was 38 miles by 27 miles, with an axis N. 42° E., and the intensity was 6. Two accessory shocks had their epicentra respectively 3 miles S. 24° W. and 5 miles W. 39° S. of Inverness.

He considers the first shock to have been due to slipping along a fault, whose position is indicated. If the fault has a hade, the shock will usually extend further on the downthrow side, hence the hade in this case is to the N.W. If the rock slips down, the particles on the slipping face "would be drawn upward by the friction." "Hence on the northwest side . . . the movement should be first upward."[1]

In one place—Dyke—it was first downwards; this, there-

[1] We can understand this if it means that the slipping itself, being a gradual motion, is not felt but that when it is *suddenly* stopped, by what the author elsewhere calls "impulsive friction," there seems to be a shock in the reverse direction.

fore, is on the other side of the fault, the position of which is thus determined, and the axis of the isoseismal lines gives the direction. It makes an angle of 15° with the Great Glen fault. No such fault has been observed on the surface. On account of the duration of the shock and the elliptic form of the isoseismals, he considers "that the seismic focus was of considerable length in a horizontal direction, perhaps as much as four or five miles, if not more."[1] Later shocks may have been caused by the strain on the triangular block between the above supposed fault and the main fault.

***39. Davison, C.—On the British Earthquakes of 1890, with the exception of those felt in the Neighbourhood of Inverness.**

Geol. Mag., Dec. 3, vol. viii., p. 450.

One was felt in Yorkshire in the night of June 25-26. Intensity iv., epicentrum ½ mile N.E. of Walton. The disturbed area was 11½ miles by 7 miles. This small size, and the horizontal motion felt at Walton, indicate a very shallow seismic focus. There is no fault in the neighbourhood, and he concludes that this earthquake is due, like some others explained by G. A. Lebour, in Sunderland, to the falling in of blocks in the roofs of subterranean cavities of the Magnesian limestone.

There was another earthquake in Kintyre on July 24, of intensity v., its epicentrum being a little west of that of the previous year. Ten minor shocks were also recorded by seismographs at Invergarry, and two at Feddau, and a doubtful one occurred at Tulliallan, Perthshire.

40. Milne, J.—Tenth Report of the Committee . . . appointed for the purpose of Investigating the Earthquake and Volcanic Phenomena of Japan.

Rep. Brit. Assoc. for 1890, p. 160.

During the year 121 earthquake shocks have been recorded by the Gray-Milne Seismograph—one of which, that of Kumanto was very destructive. The most disturbed districts are the extremities of all the peninsulas jutting out into the ocean, though 80 have been felt in the alluvial plain of Tokio. There is no evidence of these being especially connected with volcanoes. The sum of the areas shaken in three successive years has been 5·4, 3·8, and 5·5 of the whole area of the empire. No law seems evident as to the time of year or day when they are most frequent. It has not been possible to connect magnetic disturbances with the earthquakes, but in many cases electric disturbance has accompanied them, but has not extended beyond their region of influence. The

[1] The words "focus" "centre of intensity," and "epicentrum" are here used in a special sense, as such words usually refer to *points*.

air in these cases invariably becomes electrically negative, the change of potential being sudden and sometimes amounting to 30 volts, and it is only gradually recovered. The rate of earthquake propagation has been between 200 and 600 metres per second.

ELEVATION AND DEPRESSION.

41. Reade, T. M.—An Outline of Mr. Mellard Reade's Theory of the Origin of Mountain Ranges by Sedimentary Loading and Cumulative Recurrent Expansion: in Answer to Recent Criticisms.

Phil. Mag., ser. v., vol. xxxi., p. 485.

Mathematical investigations are considered to prove that the earth as a whole is solid, as the pressure at a depth of 30 miles would be about 100 tons per square inch, which would probably raise the melting point, and at great depths make the rocks solid.[1] All great mountain chains are composed of great thicknesses of sedimentary and volcanic deposits, which, however, are not confined to their immediate neighbourhood.[2]

As some of these mountain ranges contain eight or ten miles thickness of strata, they must have been laid down in troughs, gradually sinking to twice the depth of the present ocean.[3] The deposit of such masses will squeeze out the yielding crust below, and raise the level at the sides. The rise of the isogeotherms will make the ten miles of strata 1,000° Fahr. hotter at the base, reckoning a rise in temperature of 1° in 50 ft.[4] The rise will not be uniform, and will accumulate stresses till the expanding rocks overcome the weight of sediment. During the deposit, in fact, the base will be sinking, and the isogeotherms with it, and only after long sedimentation begin to move upwards. When once the elevation is established, there will be a movement of the heated matter of the earth towards the axis.[5]

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[1] There is no necessity that there should be any pressure at all at a depth of 30 miles if the crust be solid; there is none within a hollow shell, and many beds of coal would crumble to dust if subjected to the full pressure of the strata above them.

[2] This fact would appear to show that great thicknesses of sediment are not specially connected with mountain chains.

[3] It has scarcely been proved that all these strata were ever vertically one above the other; the area of deposit may have shifted.

[4] Probably far too high an estimate.

[5] It seems to be forgotten that expansion takes place in all directions, and would drive any mobile matter away.

He has found by experiment on several ordinary rocks that the expansion is 2·75 ft. per mile per 100° Fahr., and the contraction due to weight will take place first. He "*assumes* that the surplus due to the cubical expansion of a horizontal sheet is thrown into a ridge," and the effects will be cumulative, as seen in the ridging up of the lead lining of a sink. Subsequent contraction produces normal faults at the sides. The recurrent heating is an essential part of his theory.

***42. Davison, C.—Note on the Expansion Theory of Mountain-Evolution.**

Geol. Mag., Dec. 3, vol. viii., p. 210.

He thus defines the "expansion theory": "Masses of sediment laid down in an area of subsidence are gradually lowered to regions of the earth's crust that are at a higher temperature than that in which they were deposited. The sediment being heated expands, is crumpled and folded internally, and, bulging up at the surface, is reduced by denudation to the form of a mountain chain." To this he brings forward an objection, already formulated by O. Fisher, that the heat which passes into the sediment must be withdrawn from the immediately adjoining parts, which will therefore shrink as much as the sediment expands, and subsidence rather than elevation will be the result.[1] Even granting expansion from this cause, the effect could only be at most equal to the diminution of the earth's radius during the time.[2]

***43. Reade, T. M.—The Effect of Sedimentation on the Temperature of the Earth's Crust.**

Geol. Mag., Dec. 3, vol. viii., p. 272.

This is a reply to Mr. Davison's objection [No. **42**]. He points out that the heat is *not* withdrawn from the strata immediately below, since they are at first no hotter than the rest of the surface. As a matter of fact, the outflow of heat being here checked, they actually rise in temperature at the expense only of heat which would otherwise escape into space.

44. Oldham, R. D.—Essays in Theoretical Geology . . . 3. The Age and Origin of the Himalayas, with especial reference to the Rev. O. Fisher's Theory of Mountain Formation.

Geol. Mag., Dec. 3, vol. viii., pp. 8 and 70.

Attention is first drawn to the contrast between the Peninsular and Himalayan region, the former being of

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[1] There is a fallacy here—each section of a bar of iron, heated at one end, loses heat to the section beyond, yet the longer the bar the greater the expansion.

[2] Would it necessarily be so if the sediment were thicker than the loss of radius, and if the crumpling were allowed for ?

ancient, the latter of modern origin. That the Himalayas did not exist as a mountain range at the commencement of the Tertiary Period, is proved by the occurrence of nummulites in the Upper Indus Valley, at heights of 19 to 20 thousand feet; and lower down the same rocks lie conformably on pre-Tertiary rocks, which had not at that time been uplifted. If the pisolitic ferruginous rock of the Subathu group be the same as the laterite of the Deccan, the disturbance which separated these two parts must have been of later date. On the other hand, in the Simla region the Sirmur series is separated from the younger Tertiaries or Siwalik series by a great reversed fault, and are nowhere overlaid by them. This is best accounted for by the elevation of the region before the deposit of the latter rocks. Again, the alluvial deposits of the present valley show fairly regular zones of gravel, sand, and silt, as the hills are left, and the Siwalik series shows the same kind of zoning, the conglomerates lying not far from the modern gravels. Hence at the time of their deposition the present drainage must have been already established, and the boundary of the Himalayas cannot then have been far from the present one. But as these Siwalik deposits reach a thickness of 20,000 feet, they must lie on an area of continuous subsidence, side by side with the area of continuous mountain elevation. The boundary between these two areas, *i.e.*, between the Siwalik rocks and the pre-Tertiary rocks, is a clean-cut, generally reversed, fault, called the main boundary fault. A similar fault for the most part separates the uplifted Siwalik series from the valley alluvium, showing a shifting of the mountain boundary to the south, the Siwalik area becoming part of the rising instead of part of the sinking area. This gradual shifting to the south is shown also by the increase of size of the materials of the Siwalik deposits, so that what was once an area for silt has become an area of gravel—lying, therefore, nearer the hills. In consequence of this, the alluvium should be pushed farther south, and in this part of the valley the upper beds should be finer. This is confirmed by a boring at Calcutta, towards the south, where in a depth of 481 ft. the proportion of sand, &c., to clay increases from 0 to 81 per cent., as contrasted with one at Umballa towards the north, where in 700 ft. the proportion decreases from 59 to 6. Other borings, however, are not so decisive.

In accounting for this structure the author cannot quite accept that part of Mr. Fisher's theory which says that the shifting the centre of gravity by denudation and deposition from over the centre of flotation would cause a rotation of the mass, as this would involve the rotation of the whole of

the Central Asian plateau, but he regards the whole area as a mass floating in a magma, deepest below where it is highest above. The original elevation is due to compression and contortion. Then the elevated part will be lightened by denudation, and by flotation tend to rise, while the area of deposition will tend to sink most where most is deposited, *i.e.*, close to the area of deposition. These contrary tendencies side by side will be relieved by a fault, but compression continuing, the marginal deposits will at last themselves be elevated and form part of the rising tract, and another fault become necessary on the other side, where the newer deposits are.

45. Browne, R. G. M.—As to Certain Alterations in the Surface Level of the Sea off the South Coast of England.

Rep. Brit. Assoc. for 1890, p. 824.

The author thinks the sea can go to a lower level locally, and instances the inland cliffs of Winchelsea and Rye as being left by a local depression of the sea "The absolutely undisturbed structure of the Hastings sand-deposit" [*sic*] shows that the change of level is not on the part of the land.

STRATIGRAPHICAL PHENOMENA.

46. Burns, D.—On the Bending of Beds near Veins.

Trans. Federated Inst. of Mining Eng., vol. ii., p. 64, plate vi.

In some cases the vein bends the strata close to it into an arch-like form—this is when the fluid was able to escape. In the ordinary case, when the upthrow dips to the vein, and the downthrow away, there must be rotation about a fixed point some distance along the downthrown stratum, otherwise there would be a reversed fault owing to the induced horizontal thrust. In some cases, the dip is towards the vein on the downthrow side, and away from it on the upthrow. This he accounts for by the introduction of fluid into the crack, which exerts a normal pressure against its sides, and thus pushes the overhanging side up, and the other side down, and so tends to reverse the direction of the crack, the softer beds accommodating themselves to the changed position, while the harder remains separate. This accounts for the vein stuff being thicker in the harder beds, and lends countenance to the theory of sublimation of vein stuff.

***47. Jukes-Browne, A. J.—The Cause of Monoclinal Flexure.**

Geol. Mag., Dec. 3, vol. viii., p. 505. Abstract of paper read at the Brit. Assoc. in August, 1891.

This is a *suggestion* that strata with a monoclinal fold lie unconformably on faulted strata below. On further compression taking place, the underlying rocks will yield along the old fault lines, and the parts over a pair of trough faults will rise, and if the overlying beds are thick and pliable, they will form a monoclinal flexure; if not they will be faulted.

48. Morton, G. H.—Geology of the Country around Liverpool, p. 144. [*See* No. **91.**]

Notes that the infilling of a fault at Heswell Hill is so much harder than the surrounding strata that it projects through the soil in a long line. The faults in this district have usually a N. and S. strike, and are very numerous.

***49. Reade, T. M.—A Miniature Illustration of Normal Faulting.**

Geol. Mag., Dec. 3, vol. viii., p. 487.

A figure is given of a section in the Drift at Nevin, Carnarvonshire, in which the top is a bed of laminated silty clay, below is a cavity partly filled with sand, as of a bed removed, and at the base some more laminated silty clay, with numerous faults, showing in miniature all the features of a faulted coalfield. He says it is "evident" that the faulting is due to the contraction of the beds, either by drying or draining away of their water.[1]

***50. Reid, A. S.—Concretions and Concretionary Actions.**

"The South-Eastern Naturalist," vol. i., p. 48.

Abstract only of a paper in which the probable origin of concretions was pointed out. Some globular concretions from the Folkestone beds at Hothfield were shown.

51. Marshall, W. P.—Notes on a Trip to the Orkney and Shetland Isles and on some Singular Water-worn Rocks in Orkney.

"Midland Naturalist," vol. xiv., p. 8.

Notes a singular bed of rock on the top of the cliff at Scail, seven miles north of Stromness. It is a thin-bedded sandstone which separates into "tiles," between which are depressed lighter coloured lines like the cement, and each tile is bordered by one or more bands of discoloration. They are lozenge-shaped, with rounded angles 3—4½ in. long. Some become undercut at the edges, and at last become separate nodules of ironstone. It is suggested that the surface became cracked by shrinkage, and that the surface water, running

[1] As the hades of the faults are almost all in one direction, they seem more probably due to a failure of support beneath the bed in that direction.

down the cracks, has tended to separate the "tiles"; and that the iron oxide has gradually concentrated itself, "by some kind of molecular attraction," to the middle.

MISCELLANEOUS.

*52. Holmes, T. V.—Further Notes on the Geological Record.

Proc. Geol. Assoc., vol. xii., pt. ii., p. 67 (continued in pt. iii.).

In cases where indigenous land animals are found on islands separated by channels of more than 1,000 fathoms from the nearest mainland, as Madagascar, Galapagos, and New Zealand, the islands are in centres of recent volcanic activity, and consequently the upheavals and accompanying depressions may be greater.

The "Radiolarian ooze" of Barbadoes may only be due to unfavourable circumstances for the preservation of calcareous remains, especially as it sometimes contains them. With regard to the evidence of the deep-sea echinoid, it is of little consequence, as echinoderms generally have a greater bathymetric range than most other marine organisms.[1] There is, moreover, no evidence, by gradual change of deposit, of the descent and re-ascent.

By a survey of the general features of American Geology, it is shown that the deposits are local, and afford, in this way, no aid in correlation with English strata, and it is by no means certain that the apparent fixed points, viz., the close of the Archæan, the Coal Period, and the Glacial Epoch, were synchronous on the two sides of the Atlantic. Professor Heilprin has recently endeavoured to show, contrary to the arguments of Spencer and Huxley, that equifaunal deposits are approximately synchronous, because there are no inversions of the series, as, *e.g.*, Devonian of Britain, lying on Carboniferous of Africa. Such inversions, it is shown, could not take place, because the lower types of life in the older beds would die out when brought into competition and could not replace the higher. In cases of "homotaxial perversity," where the flora and land fauna says one thing and the marine fauna another, neither has the greater claim to regard.

*53. Seward, A. C.—Fossil Climates.

"The Naturalist" for 1891, p. 149.

The discussion is here restricted to what can be learnt from extinct Floras. After a sketch of old opinions, the Carboniferous climate is discussed. The Permo-Carboniferous or

[1] Echinologists will scarcely admit this.

Glossopteris flora of India, South Africa, and Australia is distinct in character from that of Europe, and is ancestral to the Mesozoic flora of the latter. It is associated with glacial beds in the salt range and other districts, and thus indicates a colder climate.

Thus there were two climates side by side. The Coal beds are only found in mass outside the Tropics, showing even then the effect of latitude.

54. M.—The Composition of Sea-Water.

"Nature," vol. xliii., p. 199.

Points out that the sea contains a larger relative proportion of soda salts to those of potash than would be expected from the greater abundance of potash felspars in rocks. Refers to the hypothesis that the sea was salt from the first, in which case, perhaps, the potassium first entered into combination to form silicates, and the sodium was left to condense in the water.

***55. Jeffs, O. W.—Report of the Committee to arrange for the Collection, Preservation, and Systematic Registration of Photographs of Geological Interest in the United Kingdom.**

Rep. Brit. Assoc. for 1890, p. 429.

A first list of geological photographs is here given. Copies may be obtained of the Photographers or of the Societies sending them; 275 of these have been received and registered by the Committee.[1]

Cheshire 27.—Trias, Boulder Clay, coast erosion, &c.

Cornwall 4.—S. Erth beds.

Devonshire 2.—Caves.

Dorsetshire 1.—Lulworth.

Isle of Man 7.—Various.

Kent 10.—Thanet sands and chalk pipes.

Lancashire 29.—Carboniferous Limestone and Boulders.

Leicestershire 16.—Charnwood Rocks, Lias, Boulders.

Montgomeryshire 3.—Corndon Laccolite.

Northumberland 9.—Coal-measures and Magnesian Limestone.

Nottingham 8.—Trias and Drift, Junction of Permian and Coal-measures.

North Wales 27.—Carboniferous Limestone, Coal-measures, Drift, and Boulder.

Shropshire 8.—Ordovician, Silurian, and Carboniferous Sandstone.

Somerset 9.—Midford Sands, Wm. Smith, Carboniferous Limestone, Avon Gorge.

Yorkshire 85.—Carboniferous Limestone, Junctions, Coal-

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[1] It is not stated where these registered photographs are.

measures with trees. Flagstones, Plumpton and Haddockstones Rocks, Magnesian Limestone, Oolitic Rocks of the coast, Chalk of coast, Drift and erratics (Norber).

Scotland 33.—St. Kilda, Coal-measure trees, Mull, coast scenes. A selection of 72 from the catalogue of G. W. Wilson is also given.

Ireland 42.—Giant's Causeway, Basalt and Chalk, New and Old Red, Gravels, Cave, with six selections from Wilson.

56. Bedford, J. E.—First Report of the Geological Photographic Committee of the Yorkshire Naturalists' Union.

"The Naturalist" for 1891, p. 69.

A general account of what has been done, together with extracts from the British Association List [No. **55**] of the Photographs relating to the North of England.

57. Deane, G.—The Future of Geology.

"Nature," vol. xliii., p. 303.

A chatty address on geological "things in general."

58. Davies, A. M.—The Permanence of Ocean Basins.

Proc. London Amateur Sc. Soc., vol. i., p. 90.

Discusses the force of the arguments for this, *i.e.*, 1. The absence of deep-sea sedimentary rocks. 2. The absence of sedimentary rocks in oceanic islands. 3. The distribution of animals and plants; concluding that though the general evidence is in favour of the theory, there are several cases which require caution.

59. La Touche, J. D.—On the Sounds known as the "Bausál Guns" occurring in the Gangetic Delta.

Rep. Brit. Assoc. for 1890, p. 800 [No. [**27**], 1890].

The "Bausál Guns" are sounds resembling the firing of heavy cannon at a distance. They are heard at various points in the Delta of the Ganges and Brahmapootra, and in the hills to the north of it. He considers they are not due to the surf, nor to the falling in of banks, nor to native bombs, nor to thunder, nor, perhaps, to earthquakes; but they may be caused by slight movements of the layers of silt.

59a. Chree, C.—Some Applications of Physics and Mathematics to Geology.

Phil Mag., ser. v., vol. xxxii., pp. 233, 342.

After calling attention to some definitions, he points out that theories of elasticity go upon the assumption that the strains must be small, and must be proportional to the stresses. He then enquires into the possibility of the earth's possessing an elastic solid structure consistently with these conditions. This depends to some extent upon its supposed compressibility, which is connected with a constant, called η or

Porsson's ratio, which is the ratio of the lateral contraction to longitudinal strain. When the body is incompressible, *i.e.*, when its volume is constant under stress $\eta = \cdot 5$. The result arrived at is that there is nothing in the theory of elasticity opposed to the earth's being an isotropic elastic solid, subject to the above conditions, provided its material be very nearly incompressible; but that it has a structure like ordinary metals, involves a rejection of the smallness of the strains, or of the proportionality of strain to stress. The limitations above-mentioned are not universally accepted, as Professor Darwin has assumed in one case a value $\eta = -1$, which the author regards as impossible, and Mr. Love [see No. **1**] takes $\eta = \cdot 25$, and the author himself has discussed a case under the supposition $\eta = 0$.

But the result of this work is intended to show that the shape of the earth is no argument for its internal fluidity. As an elastic and nearly incompressible solid, it could take its present shape under the centrifugal and gravitational strains to which it is actually subject, its elasticity being within the limits of the elasticity of various solids.

[This article should follow No. **1**.]

TEXT-BOOKS AND GENERAL PUBLICATIONS.

60. Cole, G. A. J.—Aids in Practical Geology.

London: Griffin & Co., 8vo, pp. 402, with 136 illustrations.

This is a most extraordinary book, it seems to tell on every subject exactly what one wants to know, and in the clearest possible way. It could only have been written by one who has had long experience in teaching, and who is yet never tired of learning. Its production is a splendid testimony to the thoroughness of the work carried on in Professor Judd's laboratory. The vigorous common-sense displayed in all questions of doubt is perfectly refreshing. The advice it gives is obviously the outcome of practical experience, and will commend itself to everyone who has like experience. It is meant, too, for those who, like most geologists, have no inexhaustible funds at their disposal. If, with this book in his possession, a student does not become a thoroughly practical, up-to-date geologist, it is entirely his own fault.[1]

[1] The method given on p. 6 for the determination of the true dip from two apparent dips might be simplified by adopting Green's method instead of Dalton's. Thus, if a bed dip 1 in 7 along one face A B, and 1 in 13 along another A C, measure horizontal lines in these directions = 7 and 13 and join the ends, then the perpendicular A D from A on B C is the direction of the true dip, and its amount is 1 in as many units as there are in A D on the same scale. Packets of jewellers' envelopes of various sizes are preferable to pieces of newspaper for putting specimens in.

It first gives hints as to equipment; next comes the examination of minerals, under which we learn about simple goniometers, specific gravity balances, heavy solutions, blow-pipe tests, and a number of the practical characters of the various minerals.

Then comes the examination of rocks, with simple observations, the newest chemical methods, isolation of minerals by immersion in liquids, the best methods of making thin slices, and the use of optical methods, which are all explained in the clearest manner; and then a full chapter on the characters of minerals in slides, and finally full descriptions of the various known rocks, with diagrams which really look like what is seen under the microscope. This occupies two-thirds of the book.

The last part deals with the examination of fossils, in which the generic characters of all the most important types are given and illustrated, with explanations of all terms used, in such a way that one may be pretty certain of determining the genus of any characteristic invertebrate fossil. Vertebrate fossils are not dealt with.

61. Geikie, Sir A.—Outlines of Field Geology. Fourth Edition.

London: Macmillan and Co., 8vo, pp. 252, with 86 illustrations.

This has "been thoroughly revised and considerably enlarged." The principal novelty is in the treatment of the chapter on schistose rocks which are recommended to be studied for: "1. The nature and distribution of the minerals; 2. The varieties and alternations of the rocks; 3. The direction of the prevalent foliation, whether or not it coincides with the bedding; 4. The evidence of crushing and the existence of thrust-planes." The nature of these thrust-planes is explained in another part of the book. Much that is new is also given with regard to the microscopical investigation of rocks. It contains throughout much excellent advice, though the details, in some cases, of how to carry out the advice must be obtained elsewhere.

62. Seeley, H. G.—Handbook of the London Geological Field Class.

London: 8vo, pp. 216.

This is a most interesting book; the author is rather the creator than the writer of it, for it consists of reports by the students themselves of the lectures and excursions. The lectures embody the general views of the author taken from wider areas than the places visited; they deal with the subject in three ways—first, the connection of the physical features with the geology; secondly, the general geology of various localities; and, thirdly, the variations of single groups of deposits. The

excursions are reported in an exceedingly life-like manner, sometimes even naïvely so—one can almost fancy oneself of the party in reading them.

The following are the places visited :—

For the Lower Greensand.—Preston Hill, Dunton Green, Sevenoaks, Bailey's Hill, Oxted, Godstone, Nutfield, Earlswood, Redhill, Holloway Hill, Guildford, and Shotover Hill.

For the Upper Greensand and Gault.—Aylesford Pottery, Otford, Dunton Green, Godstone, Merstham Road, and Guildford.

For the Chalk.—The gorges of the Medway and Darent, Otford, Dunton Green, Oxted, Merstham, the gorges of the Mole and the Wey, Hawkshill, Northfleet, Charlton, Loam Pit Hill, Croydon, Purley Junction, Godstone, Upminster, Grays, and Boxmoor.

For the Thanet Sands.—Herne Bay, Erith, Loam Pit Hill, and St. Mary Cray.

For the Woolwich and Reading Beds.—Herne Bay, Kits Coty House, Erith, Charlton, Loam Pit Hill, Addington Hill, and Chesham.

For the London Clay.—Herne Bay, East Church Cliffs, and Loam Pit Hill.

For the Brick Earths and Gravels.—Crayford, Grays, Ilford, and Chesham.

Incidentally, the following analyses are given :—

1. By **P. G. Sanford.** Top of Folkestone Beds.

Silica	98·80
Oxide of iron and alumina	0·47
Lime	0·09
Magnesia	0·05
Combined water	0·42
	99·83

2. By **P. G. Sanford.** Blue Fuller's Earth (1) and Yellow (2) at Nutfield.

(1)—Insoluble—		(2)—Insoluble—	
$S_1 O_2$	52·81	$Si O_2$	59·37
$Al_2 O_3$	3·46	$Al_2 O_3$	10·05
$Fe_2 O_3$	1·30	$Fe_2 O_3$	3·86
Ca O	1·53	Ca O	1·86
Mg O	0·86	Mg O	1·04
	69·98[1]		76·13[1]

[1] There seems to be some mistake here, as the figures do not add up as stated.

Soluble in acid—		Soluble in acid—	
Fe_2O_3	2·48	Fe_2O_3	2·41
Al_2O_3	3·46	Al_2O_3	1·77
CaO	5·87	CaO	4·31
MgO	1·41	MgO	1·05
P_2O_5	0·27	P_2O_5	0·14
SO_3	0·05	SO_3	0·07
$NaCl$	0·05	$NaCl$	0·14
K_2O	0·74	K_2O	0·84
H_2O	15·57	H_2O	13·19
	99·86		100·05

3. By **P. G. Sanford,** Gault of Dunton Green. 4. By **C. W. Meanwell,** Godstone Chert.

(3)—Insoluble—	
SiO_2	46·43
Fe_2O_3	2·05
Al_2O_3	15·41
CaO	0·88
MgO	0·24
	65·01
Soluble—	
Fe_2O_3	7·92
Al_2O_3	3·40
CaO	5·90
MgO	0·75
$NaCl$	0·05
P_2O_5	0·11
SO_3	0·19
CO_2	6·09
K_2O & Na_2O	0·07
H_2O	10·45
	99·97

(4.)	
SiO_2 (insoluble)	87·10
SiO_2 (soluble)	·21
Fe_2O_3	1·59
Al_2O_3	1·78
CaO	4·39
MgO	·28
CO_2	3·45
Na_2O	·45
	99·25

5. Chalk rock at Boxmoor.—(1) By **C. W. Meanwell**; (2) by **P. G. Sanford.**

(1.)		(2.)	
Silicates	·97	Insoluble	1·00
Phosphoric acid	·61	Phosphoric acid	·71
Carbonate of lime	96·77	Carbonate of lime	97·00
		Magnesium carbonate	·78

***63. Hull, E.—The Physical Geology and Geography of Ireland. Second Edition.**

London: Stanford & Co., 8vo, pp. 328, with two coloured maps.

The author states in the preface that the principal additions since the previous edition relate to:—

1. The determination of the occurrence of Archæan rock in certain districts of the west and north.
2. The determination of the peculiar relations subsisting between the Lower Devonian (or Devono-Silurian) strata and the Upper Old Red Sandstone and Carboniferous series of the southern districts.

3. Additional evidence regarding the relative ages of the trachytic and basaltic lavas of Antrim.
4. Evidence of the invasion of Ulster by a great ice-sheet from the Grampian Mountains of Scotland, during the earliest stage of the Glacial Period.

Under the first head, he enumerates as Archæan areas the northern shore of Galway Bay south of the "Twelve Bins of Connemara"; the Slieve Gamph and Ox Mountains; the western and northern parts of Erris Head and Belmullet; and the extreme western coast of Achill Island. He withdraws, however, his former conclusion as to the Archæan age of the granites and gneisses of north-west Donegal. In connection with this, he calls the Howth Hill, Bray Head, and Wexford rocks Cambrian, and maintains the organic nature of *Oldhamia.* He considers there are two types of Lower Silurian rocks—the normal fossiliferous ones in the south-east, and metamorphic representatives in the north-west and north-east, comparing these latter with the rocks of the Central Highlands of Scotland, and their quartzites and limestones with those of Durness. The proofs he offers are: that they underlie the Upper Silurian—"the geological age thus indicated being Lower Silurian"; that they contain annelid tubes; that there are marks which may be graptolites, also serpula-like forms that may be corals, and coral-like forms in the limestone of Culdaff. [*See* Nos. **122**, **123**, 1890.][1]

On the second head, he draws attention to the great unconformity between the Dingle Beds which pass downwards into Upper Silurian and the Upper Old Red Sandstone with the Kiltorcan Beds, as also between the latter and Glengariff Grits.

On the third point, he states that the trachyte-porphyry of Antrim with tridymite is the earliest eruption. Next comes the vesicular basaltic lavas, with bands of bole; and, lastly, the solid augitic lava with columnar structure. Sir A. Geikie, however, considers the trachytes of Antrim to correspond to the granophyres of Mull, and to be the latest, as no fragments of them are contained in the surrounding basalts. In reply to this, the author states that such fragments have now been found in the ash beds between the lower and upper basalts at all events, and the junctions with the lower ones are not well seen, and it is unlikely an acid eruption

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[1] These proofs are consistent with their being older than the Lower Silurian—as the rocks of the central Highlands may be pre-Cambrian. Their underlying the Upper Silurian only proves them older, and not necessarily the next in order, and Sir A. Geikie has announced the discovery of annelid tubes even in the Holyhead quartzite.

should occur *between* two basic ones. Moreover, the trachytes are not like the granophyres of Mull, but they correspond to earlier Scotch trachytes.[1]

On the fourth point, he states that on the northern part of Ireland glacial striæ run N.E. and S.W., pointing to the Grampians as the source, and mentions boulders of Scotch rocks which have been brought. He says that "there can be no doubt whatever" that the Lower Boulder Clay is the product of an ice-sheet.

STRATIGRAPHICAL GEOLOGY.

PRE-CAMBRIAN.

*64. Callaway, C.—On the Unconformities between the Rock-Systems underlying the Cambrian Quartzite in Shropshire.

Quart. Journ. Geol. Soc., vol. xlvii., p. 109.

This paper is intended to controvert the statements made by J. F. Blake—so far as they are opposed to the views of the author—(*see* No. **117**, 1890). [To avoid confusion the latter will be here called C, the former B.]

I. *The Felsites.*—In the Church Stretton area, B said, "the volcanic rocks are *extruded*" from the slates. C complains that he gave no proof of *intrusion*, and replies that the junction is a fault, and volcanic mud, &c., cannot behave like a trap rock. On Helmeth Hill he "could not find any slate near any igneous rock, except the . . . dolerite," and the so-called "rhyolite" is "a good quartz and felspar grit!" On Ragleth a slate or shale "which may be Longmyndian" certainly dips in a westerly direction "in conformity with the apparently overlying Uriconian grits and argillites"; but "a few yards further south the slate is immediately succeeded by a band of felsite" like that of a dyke on Charlton Hill, and which is, therefore, probably also a dyke. In the Pontesford Hill area he has examined two specimens "rather more shaly

[1] It is not even certain that the acid rocks of Mull *are* later than the basic, for Professor Judd thinks the contrary.

than usual, and, therefore, more susceptible of alteration" and can find no signs of alteration. "As this crucial case breaks down on examination," he "thought it needless to re-examine the other masses of Uriconian."

II. *The Alleged Unconformities.*—He objects to B's figure of Narnells rock, where "grit is shown as squeezed into the slates so as to be nearly conformable." "There is," says C., "no unconformity whatever." Further on he adds, "on the west . . . the grit . . . appears to have been a little squeezed into the slate, so that here and there a trivial unconformity between the two beds is apparent." Further on he mentions a seam of slaty rock, and a band of thin-bedded grit within the upper part. It is stated that this grit can be followed on the strike to Callow Hollow and Lightspout. He has also found in the green grit of Ashes Hollow a pebble which is certainly volcanic in origin, but may be an altered mudstone.

III. *The Conglomerates and Grits.*—On Cardington they are intercalated in the volcanic series; for in the ravine above "the Yells" he has observed a strike E. and W. in nearly vertical grit, part of which is almost black. He has also found a red grit behind the Woodgate quarry "almost on the strike of the green grits," and gives a section indicating his idea of the relations in which bands of grit are drawn conformable to rhyolite. The red grit on Caradoc has the same direction of dip as the associated halleflintas. Of Charlton Hill he gives an illustrative section N. to S., showing little else than grit and conglomerate dipping N. "One of the grits is of the ordinary Wrekin type," and thus "distinctly Uriconian," and one within two feet of the supposed Cambrian. The grits in the lane dip N. at 70'—75°, and in the boss to the south there are typical Uriconian ashes and grits.

At Ercal he can find nothing to show that the granite is intrusive in the felsite, nor any proof of the intrusion of the felsite in the granite.

He then notes that, whereas the strikes in the "Longmyndians" are N.N.E., those in the "Uriconian" of the Wrekin are E. to E.N.E., and in the southern part E. to S.E., and gives a map to show this. The junction between the two near Church Stretton he considers to be "certainly a fault at the northern end, near Caradoc coppice," and at Hazler the slate loses its lamination and has a burnt appearance, which he thinks is due to a hidden dyke of dolerite. The "Uriconian" is essentially a volcanic formation. On Hazler he has seen grit rising "into the slate in a somewhat dome-like form," and such irregular lumps of grit are explicable only as the result of direct volcanic action. The "Longmyndian" is

essentially sedimentary, and this indicates a considerable interval between it and the Uriconian.[1]

***65. Blake, J. F.—On some Recent Contributions to Pre-Cambrian Geology.**

Geol. Mag., Dec. 3, vol. viii., p. 482.

A controversial paper in reply to observations by Sir A. Geikie [*see* No. **412**], Dr. Callaway [*see* No. **64**], and Miss C. A. Raisin [*see* No. **76**]. He points out that he had already recognised the similarity to Archæan of the mass of gneiss in the centre of Anglesey. He repeats the evidence for the fault which separates the northern Monian district in Anglesey, and says it is really a thrust, producing only apparent conformity in Carmel's Bay. If there were no fault, identical chloritic schists would be Bala in one place, and underlie Arenig in another, within two miles. The so-called Dalradian rocks of Scotland are by their description Monian in part.

In the Shropshire district he points out that Narnells rock is not the best place to prove unconformity in the Longmynd, and that the only evidence that has as yet been given for the age of the volcanic group is in favour of its being younger than the eastern Longmynd rocks, and gives reasons for regarding the red grit as, in most cases, superficial.

He also acknowledges that he has been deceived in the section at Bryn Efail, Canarvonshire, supposed to *show* the felsite, overlying slate and grit, though the remaining evidence is untouched.

***66. Hicks, H.—On Pre-Cambrian Rocks Occurring as Fragments in the Cambrian Conglomerates in Britain.**

Rep. Brit. Assoc. for 1890, p. 803.

Already published in the Geological Magazine [*see* No. **120**, 1890].

***67. Hicks, H.—The Effects Produced by Earth-Movements on Pre-Cambrian and Lower Palæozoic Rocks in some Sections in Wales and Shropshire.**

Rep. Brit. Assoc. for 1890, p. 804.

Already published in the Geological Magazine [*see* No. **137**, 1890].

68. Geikie, Sir A.—Some Recent Work of the Geological Survey in the Archæan Gneiss of the North-West Highlands.

"Nature," vol. xliv., p. 480. (Read at B.A.)

It had been supposed that the fundamental gneiss was entirely igneous, but in Ross-shire have been found bands of limestone, with mica schists and quartz, and graphitic schists

[1] For the points of importance in this, *see* No. **65**.

—like those of the Eastern and Central Highlands, belonging to the Dalradian series. These rocks are usually difficult to divide off from the gneiss, but they have now been found sharply marked off, as though the gneiss had been erupted into them.

***69. Coates, H., and Macnair, P.—The Rocks of Highland Perthshire: their Origin, Plication, and Denudation.**

Trans. and Proc. Perthshire Soc. Nat. Sc., vol. i., p. 221.

The succession in this country is:—

6. Quartzites, grits, greywacke.
5. Mica-schists and quartz-schists.
4. Calcareous mica-schists and limestones.
3. Mica-schists and quartz-schists.
2. Quartzite, grit, greywacke, and conglomerate.
1. Clay slates and phyllites.

No. 6 runs from Loch Katrine to Loch Earn; No. 2 is seen in Glen Lochy, Tyndrum, Glen Lyon, Glen Tilt, and Ben-y-Gloe; No. 1 crosses from Stonehaven to Bute, is worked for slate at Dunkeld, and is seen at Loch-of-the-Lowes, near the Bridge of Cally, at Craiglea, Comrie, and Callander; Nos. 3 and 5, form Ben Lawers, Craig-na-Challeich, and Benmore, and occur along the shore of Loch Tay; No. 4 outcrops in the valley of the Dochart, along the shores of Loch Tay, and in the Upper Tay Valley, and in Glen Lyon.

These are thrown into gentle synclinal and anticlinal folds, with faults running parallel to the axes in a north-east and south-west direction.

***70. Williams, A. H.—The Geology of Sutherlandshire.**

Proc. London Amateur Sc. Soc., vol. i., p. 93.

The oldest rocks cannot have been intrusive, as then they must have intruded into something—perhaps the quartz grains are the only relics of this. The limestones in the gneisses may be of solfataric origin. The garnets in schists, being intact, must be of later origin.

***71. Hull, E.; Kinahan, G.; Nolan, J.; Cruise, R. J.; Egan, F. W.; Kilroe, J. R.; Mitchell, W. F.; McHenry, A.—Explanatory Memoir to accompany Sheets 3, 4, 5 (in part), 9, 10, 11 (in part), 15, and 16 of the Maps of the Geological Survey of Ireland, comprising North-West and Central Donegal.**

Mem. Geol. Surv. Ireland, pp. 174. Price 5s.

In this district there are two central ridges of granite running N.E. and S.W., with the remarkable Gweebara valley between. These are flanked on either side by a series

of quartzites, schists, and limestones. The author (E. Hull) formerly thought that the latter were unconformable on the granite, which was therefore considered Archæan. The reasons were that the quartzite "appeared to pass transgressively across the granite series," and that in the limestones and quartzites overlying the granite were pebbles of granite, schist, and limestone. He now, however, with the great majority of his colleagues, thinks the granite transgresses across the other rocks.[1] The pebbles may have been derived from another hidden granite. The main reason for the change of opinion is that, in the north, granite is seen intruded into quartzite, and "the identity of the granite rocks in both regions is supported by all the surveyors who are personally acquainted with the country."

The general succession of the metamorphic series shows the following *apparent* descending order:—

5. Croaghan Hill and Rathmelton grits and flagstones.
4. Millford schists and Epidiorites.
3. Knockalla and Lough Salt quartzite group (Errigal and Muckish).
2. Lough Gartan limestone and dolomite group, Falcarrah schists and limestones.
1. Glencolumbkille schists.

This is not believed by some to be the real order, which is more probably 3, 2, 1 and 4, 5.

The Glencolumbkille schists are lead-coloured, micaceous, invaded by sheets of granite, and 1,500—2,000 ft. thick. They contain staurolite.

The Lough Gartan limestones include chloritic schists, dolomite and quartz schist, with sheets of epidiorite. In the associated shales are pyritous marks having the form of *Diplograptus*. In the Ards district the limestones form beautiful marbles. In the Gweedore district there are some remarkable mica schists, and the limestone itself is schistose, and in the Dunlewy district contains actinolite, and, where surrounded by granite, idocrase, epidote, and garnet. In the Dungloe district are gnarled mica schists, with various pseudomorphs. It is in these limestones, in the Inishowen district, that the coral-like forms compared to *Syringopora* and *Halysites* have been obtained.

The quartzite group of Knockalla, Knock Salt and Errigal is the lower band. The rocks are much penetrated by dykes, and much shattered at their junction with the granite. It is in these, at Croaghan Hill, that the conglomerates occur, and elsewhere lie directly on the limestone. In the Glenfin district

[1] But which is it? does *one* granite transgress across *several* sedimentaries, or *one* sedimentary across *several* granites?

they are much shattered and sheared, their real thickness of 1,000 ft. being increased to an apparent thickness of 3,000 ft. Mr. McHenry considers that the boulder bed here could not have been supplied by the local rocks, but that the stones have been brought by floating ice from some Archæan land-surface to the north-west of the British Islands. In the Gweedore district two varieties, called, respectively, felspathic and gneissose quartzites, have been described. In Muckish the quartzite is 1,600 ft. thick. To the north of Carntreena the intrusions of the granite may be observed. In the Errigal district the quartzite is false-bedded, and contains pebbles of felspar and quartz; but the great apparent thickness, 3,200 ft., in Errigal is due to folding. South-west of Dunlewy, and elsewhere, a "mullion structure," or fluting, due to shearing, is seen. In the Bloody Foreland masses of the quartzite are caught up in the granite and converted into a highly gneissose rock, which is banded with felspar particles. In the Aran Islands the associated schists contain chiastolite, and tourmaline occurs in the quartz. In the Rathmelton and Letterkenny district there are numerous "interbedded basic eruptive masses," and one or two masses of steatitic schist, called "camstone." The thickness in Knockalla is reckoned at 1,000 ft.

In the Kilmacrenan district **G. H. Kinahan** gives five localities where an unconformity at the base of the quartzite may be seen, *i.e.*—1. In the bed of the Leanan, at Milltown, a greenish quartzose breccia lies on the edges of green phyllites, that dip S.E. at 75°; 2. A mile S.W. of Kilmacrenan, the older rocks are vertical, and the quartzite dips N.W. at 30°; 3. West of Meeting House vertical phyllites strike at, and seem to go under, a shallow basin of quartzite; 4. A mile N.W. of Kilmacrenan, vertical phyllites strike at the great quartzite, dipping S.E. at 40°; 5. S.W. from Doon Lough the quartzites dip S.E. at 10°—20°, the associated presumably older rocks dip N.E. (In a note Sir **A. Geikie** says these apparent discordances may be explained by the greater yielding of the schistose rocks to cleavage and shearing.) In the midst of these schists is an old volcanic neck called "Doon Rock." At Cranford are 1,000 feet of sericitic schists, and "here the limestone and orange dolomite appear in mass (800 ft. thick), apparently at the base of the sericitic series."

The Millford schist and epidiorite group rests on the quartzite (but in a note Sir A. G. says "there is reason to believe," though the reason is not stated, "that it may really represent the Glencolumbkille group, and some still older schist"). The schists are sericitic. There are three particular s heets of epidiorite which are sometimes columnar,

By the coast of Lough Swilly there are six, some of which are regarded by Mr. Kinahan as contemporaneous, for the usual reasons, particularly that where they are numerous one may lie either directly on another, or with only a thin band of schist between.

The Croaghan Hill and Rathmelton grits contain worm tubes and thin beds of limestone and pyrophyllite (camstone).

***71a. Kilroe, J. R.—Explanatory Memoir to accompany the Maps of South West Donegal. Sheets 22, 23, 30 and 31 (in part) of the Geological Survey of Ireland. Chap. V. Metamorphic Groups of the Region.**

Mem. Geol. Surv. Ireland.

The groups here represented are the Millford schists—the great quartzite group of Knock Salt—the Lough Gartan group and the Glencolumbkille schists.

The *Glencolumbkille schists* are dark grey, flaggy, and sericitic, with folia of silvery mica and small garnets. They show strain-slip cleavage. An alternation of more micaceous and more siliceous bands shows the cleavage crossing the bedding, and irregular in the siliceous bands. Some anomalies of dip may be accounted for by over-folding, so that the pyritous schists of Loughros belong here.

The *Lough Gartan Group* consists of dark pyritous, frilled schists, interspersed with light-coloured limestone bands dovetailing among them. Round Leahan Hill the limestone overlies quartzite, with a boulder bed intervening, showing that the strata are here inverted. The succession returns to the normal at Ardara. North of Glenties, the schist is eyed with felspar. The schist and limestone skirting Gweebara estuary are referred to this group. Other bands are mentioned at Russel's Ferry, north of Cloony Hill, Dunmore Hill, and Cashelgolan. In Dunmore there is a double frilling of the schist, making the best example of strain-slip cleavage in the district. The schists are here used for roofing slates. They contain staurolite and chiastolite near the granite.

The Quartzite Group.—The basal boulder bed is absent from 7 miles north-east of Glenties to 4 miles west of Ardara; probably on account of overthrusting. West of Lougheraherk the boulders in calcareous schist are of red granite, up to 10 in. in diameter by 2 ft. long. On the north side of Glencolumbkille valley, the pebbles in the quartzite are of grey granite up to 18 in. long. This bed is well exposed on the east shore of Malin Bay, with pebbles up to 21 in. by 12 in., in a fine slaty matrix with which they have been drawn out. Near Crumlin Burn there are appearances of false bedding by the overlap of quartzite. The following are the principal

varieties of pebble in this boulder bed: 1. Grey pyritous granite, not identifiable in the district. 2. Pink granite, with little mica sometimes in large boulders. 3. White and pink quartz. 4. Mica schist, and fine-grained gneiss in lenticles. 5. Granulitic quartzose pebbles, occasionally foliated, also friable calcareous grit. They do not form a true conglomerate, and he appears inclined to accept McHenry's suggestion of floating ice.

The quartzite on Slieve League is characteristically flaggy, and is brecciated in places. Other localities noticed are Leahan, Slieve Tovey, Aghla, and Crockuna. These quartzites are weathered into fantastic forms,and are pierced by dykes along the coast.

The Millford Schist Group consists of silvery grey or dark micaceous or siliceous schists. Seen in Crownarad Escarpment, and in the Glen River Valley, and Teelin Bay. Numerous quartz reefs follow the contortions. In some of the schists are large crystals of black mica, crossing, and consequently subsequent to, the foliation. A magnetic needle placed on the surface of these schists ¾ mile S. by W. of the summit of Mulnanaff showed a deflection of 48°—yet nothing ordinarily magnetic can be observed in the locality. It is suggested that the magnetic effect may be connected with the arrangement of the rock particles.[1] The lighter-coloured schists have produced "Silver Hill." Near Glenties there is saccharoid marble.

72. Geikie, Sir A.—Explanatory Memoir to accompany Sheets 31 (in part) and 32 of the Maps of the Geological Survey of Ireland. Chap. III.

Mem. Geol. Surv. Ireland, pp. 45. Price 1s. 6d.

In the triangular tract of country between Ballyshannon and Loch Erne "the rocks present characters so closely resembling those of the more ancient gneisses of the Scottish Highlands, that there can be little doubt in assigning them to the Archæan series." Of these rocks 24 specimens have been microscopically examined by J. J. H. Teall, and referred to granites and pegmatites, granulites and granulitic gneisses, coarse-grained gneisses, biotite schists, felspathic eclogites, epidiorites, amphibolites, and hornblende schists. The general dip of the foliation is N.E. or N., and the surface is hummocky. The oblique lamination seen in some is referred to the "flattening down and shearing of a crumpled structure." There are also a number of basic dykes, partaking of the later, but not of the earlier, foliation. These gneisses are very distinct from the younger phyllites, &c., which he has called Dalradian. At the base of the latter

[1] In which case, would it not be more generally observed?

flattened ellipses of quartz may represent sheared conglomerates.[1]

***73. Kinahan, G. H.—A New Reading of the Donegal Rocks.**

Scient. Proc. Royal Dublin Society, vol. vii., n.s., pt. i., p. 14, pls. i.–vi.

This paper is written before the publication of the views of the Geological Survey [*see* No. **71**]. It was written in 1886, but permission for its publication was not granted; and the writer's statements were afterwards partly modified.

He wishes to show that the older rocks of Donegal belong to two, if not to three, distinct unconformable series. These he calls the Older and Later Period rocks. The older series are divisible into: A. Gneiss and foliated granite series. B. Gartan schist series in six subdivisions. C. Gregory Hill series. Part of the gneiss of A is so quartzose that it has been confounded with a quartzite of the later group. The Later Period rocks consist of the Great Quartzite, the Cranford Sericitic series, the Great Schist series, the Killygarvan Volcanic series, the Killygarvan and Knockybrin Grit series, the Kintale and Lubber Volcanic and Limestone series, the Barn Hill Grit series, and the Manor Cunningham series. To the west of Lough Swilly they have been upthrust from the south-east. The succession is best seen in the Inishowen district, which affords the key to Kilmacrenan. From Knockalla to Swilly river the newer rocks overlap the older. In the Knockanteenbeg outlier the great quartzite contains beds of pebbles resembling the older gneisses or granite veins in the Gregory Hill series. These have been considered to be boulders brought by ice from a distance, but they have not the character of glacial accumulations, and Dr. Hyland states that the boulders resemble the local granite. To the E. of Glen the quartzites have also been confounded, but they have not the same associates. South-west of Doon Rock the quartzites dip S.E. at 25° and the older rocks N.W. at 30°. At Treantagh (sheet 10) the old rocks are vertical and the quartzites lie across their edges. It has been stated that in Inishowen, Kilmacrenan, and Boylagh the rocks are inverted, and the Cranford Sericitic series really underlies the quartzite, and is the equivalent of the Lough Salt Limestone series. The author, however, gives details to show that these two series are quite distinct in character, and the latter nowhere lies without unconformity under the quartzite as the former does above it.

He considers that the older series are not Lower Archæan,

[1] In the original map of the district here described (1885) the rocks are coloured as quartzites and granites in separate areas, the former of these, near Ballyshannon, are now called "muscovite-biotite-gneiss."

but may be of the age of the Ontarians, while the newer may be possibly Ordovician—and the Manor Cunningham series may be unconformable also, and represent a distinct newer group.

74. De La Mare, C. G.—On the Correlation and Relative Ages of the Rocks of the Channel Islands.

Rep. and Trans. Guernsey Soc. Nat. Sc. and Local Research for 1890, pp. 30–36.

Follows the views of E. Hill and M. Noury, giving a general sketch of the geology.

CAMBRIAN AND SILURIAN.

75. Various Authors.—Discussion on the Question of the Classification of the Cambrian and Silurian.

Compte Rendu Congrès Géologique International (1888) (published 1891), pp. 221.

Hicks, H., adopts a three-fold classification, with "Ordovician" for the middle member.

Marr, J. E.—The adoption of "Ordovician" defines, at the same time, the other two terms; for all three together, he proposed the collective name "Barrandian."

Lapworth, Ch., divides the Palæozoic into Proterozoic and Deuterozoic, and the former, like the latter, is divisible into three. He then explains the source of the name Ordovician.

Walcott, C.—The zone of *Olenellus* had always been considered to overlie that of *Paradoxides* in America till *O. Kjerulfi* was found below *Paradoxides* in Sweden, and he has now (1888) found a section at Manuels Brook, Baie de la Conception, Newfoundland, where the order is undoubted, with a northerly dip of 12°—15°.

8. Shales and grits with *Orthis*, 400 ft.

7. Black clay slates (*Paradoxides*, *Microdiscus*, *Agnostus*, *Conocoryphe*), 295 ft.

6. Green clay-slates, fossils of *Paradoxides* zone, 270 ft.

5. Limestone, 2 ft. 4 in.; red slate, 4 ft. 3 in.; green slate, 40 ft.

2. Grit, shale, and impure limestone, with *Olenellus Broggeri*, and sixteen species of the zone, 25 ft.

1. Conglomerate resting on gneiss, 35 ft.

In New York, and the Rockies, the fauna of the *Paradoxides* zone is represented by other genera.[1]

Hunt, S., adopts "Ordovician," but not the "Taconic System," which included Cambrian and pre-Cambrian rocks.

[1] *Olenellus* has since been found at the base of the Cambrian, in Britain.

Torell, O., considers the Cambrian fauna equivalent in magnitude and importance to the Upper and Lower Silurian, and will not adopt Ordovician.

Gosselet, J., will not accept the terms Protero- and Deutero-zoic, on account of the importance of the Devonian.

Dewalque, G., objects to Protozoic, as there are pre-Cambrian fossils.[1] He was formerly in favour of "Ordovician," but since he understands that Taconic is equivalent to the lower part, the name Cambrian must be kept for the middle part of the series.

Geikie, A., thinks Ordovician unnecessary. Lower Silurian is perfectly satisfactory.

Blake, J. F., said that if the fauna of the schists of Anglesey were ultimately proved to be below the ordinary Cambrian, there would be four faunas, the two lower might then be Upper and Lower Cambrian, and the two higher the Upper and Lower Silurian.

Delgado, J. F. N.—In Portugal there is a system of schists below the primordial zone, which they call Archaic; these pass gradually into the crystalline schists. There is always unconformity between the second and primordial faunas, but only a local one between the third and second. The two lower thus form one system, and the two upper another.

Gilbert, G. K., considers two systems better than three for the purposes of universal cartography.

*76. **Raisin, Catherine A.—On the Lower Limit of the Cambrian Series in N.W. Caernarvonshire.** Quart. Journ. Geol. Soc., vol. xlvii., p. 329.

This paper is written for the purpose of combating the "new interpretation which has been recently proposed" by J. F. Blake in Quart. Journ. Geol. Soc., vol. xliv., p. 271.

In the Bangor district the authoress states that the lithological resemblance of the rocks above and below the supposed basal Cambrian conglomerates exists only in the halleflintas, and she knows of no clear distinction between halleflintas of pre-Cambrian and of Cambrian age. They are not "strictly conformable" as she has found some of the lower rocks with a N.N.E. strike. She also objects to some of the mapping on the west side of the faults. If the Twt-hill conglomerate is Arenig, the whole of the Cambrian must be wanting at Caernarvon, and the overlap be much greater than has been supposed.

With regard to the age of the Llya Padarn felsite, the authoress states that argillites on the north of it are like others on the south, and she draws attention to some con-

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[1] The word proposed, however, was Proterozoic.

glomerates which have been omitted from the map. If the Moel Tryfaen conglomerate contains fragments of Cambrian slate, they must have been prepared by "a process of rapid manufacture indeed." She cannot accept Professor Green's unconformity. The vertical beds below are diabase dykes. The Cambrian period is not generally considered one of volcanic activity, and no difference has been pointed out between the felsites of Llya Padarn and Dinorwic. There are felsitic conglomerates west of Bryn Efail, and the dip of the argillites is irregular. The supposed "slate" at Bryn Efail quarry is only the edge of the fine-grained diabase dyke. The supposed "chiastolite" is decomposed plagioclase, and the supposed "grit" is brecciated felsite, and the same explanation is given of the section in the road, hence this "crucial test, and decisive proof" fails.[1]

77. Geikie, Sir A.—On the *Olenellus* Zone in the North-West Highlands.

Geol. Mag., Dec. 3, vol. viii., p. 498, and "Nature," vol. xliv., p. 479. [Read at B.A.]

States that, "according to our present terminology, we place this [the Durness] fauna in the Cambrian rather than in the Silurian system." In the "Fucoid beds," a few feet below the serpulitic grit, is a zone of blue-black shales in which portions of trilobites have been found, which are referable to *Olenellus*. Other zones with the same fossil occur also in the serpulite grit itself. These beds are thus "now demonstrated to belong to the lowest part of the Cambrian system." "The quartzites are shown to form the arenaceous base of the system, while the Durness limestones may be Middle or Upper Cambrian." "The Torridon sandstone must therefore be pre-Cambrian."[2]

***78. Andrews, W.—On a Discovery of Blue Slate in North Warwickshire.**

Proc. Warwickshire Nat. and Arch. Field Club for 1890, p. 9.

The slate occurs unconformably beneath the Carboniferous series half-way between Atherston and Nuneaton, at Snow Hill, near Chapel End, and contains *Olenus* and *Agnostus*.

***79. Jennings, A. V., and Williams, G. J.—Manod and the Moelwyns.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 368.

1 There can be little doubt that the section at Bryn Efail is here proved to be worthless. The other points are dealt with in a later paper by J. F. Blake.

2 This depends on the assumption that the whole genus *Olenellus* is absolutely confined to the Lowest Cambrian. If the Durness fauna were still believed to be Lower Silurian, this very discovery might be taken as proof of a wider range for the genus.

The district described is a triangular area with the granite of Tan-y-grisiau in the centre, an ascending series from Tremadocs to Llandeilos striking N.E. on one side and S.E. on the other.

The black Tremadoc slate lies partly below but mainly above the intrusive granite. Near the contact it becomes "hornfels," and shows dark spots, caused by the absence of a chloritic matter. These are, perhaps, embryo andalusite. The material was, perhaps, originally a fine ash, but there is no microscopic evidence for this. The Garth grit is about 13 ft. thick, and is also altered.

The Arenig series commences with spotted, flaggy rocks which quarry in large blocks. With an increase of clayey material and blue colour, the rock becomes the Lower Slate bed, which has never paid for working. One band contains black pebbles with oolitic grains.

The igneous rocks consist of Lower, Middle, and Upper Agglomerates, separated by slate beds. At the base of the Lower is a thin band mapped as "felstone," which is more probably a compact ash, and in the Upper is a thicker one. These do not, as has been asserted, alter the adjacent rocks. The fragments of sedimentary rocks are of large size. In the Middle band, which dies out northwards, they are sometimes indefinite, as though originally soft. In the Upper they had been cleaved before being embedded. The Arenig slates are not of commercial value.

The overlying slates belong to the Llandeilo, containing in one place *Climacograptus Scharenbergi* and *Didymograptus Murchisoni*, and in another *C. celatus* and *D. dentatus*.

The authors then give detailed evidence for a somewhat different mapping from that of the Geological Survey, as the beds are traced towards the east.

The rock of Tan-y-grisiau is seen penetrating the strata in all directions near Dolwen and Foel; it catches up pieces of cleaved Tremadoc slate, and alters the surrounding rocks. There are, however, some roughly parallel veins of biotite and chlorite, which give it a gneissic appearance, and the ingredients, which are mainly quartz and felspar, are crushed and strained. An analysis by **L. W. Fulcher** gives—

SiO_2	75·02
Fe_2O_3	2·89
Al_2O_3	12·88
CaO	1·17
MgO	·32
K_2O	5·03
Na_2O	3·28
H_2O	·60
	101·19

which closely agrees with that of the eurite of Cader Idris.

80. Russell, R.; Goodchild, J. G.; Strahan, A.; and Hatch, F. H.—The Geology of the Country around Mallerstang, &c.

Mem. Geol. Survey, chaps. ii. and iii.

The Lower Silurian rocks of this district comprise: The Ashgill shales, contemporaneous volcanic rocks, and black limestone and shale, all belonging to the Coniston limestone series. The base is nowhere reached, but the volcanic rocks have a thickness of from 70 to 80 ft., and the Ashgill shales a maximum of 850 ft. They are exposed in five distinct inliers.

1. Hebblethwaite Gill with Ashgill shales only.

2. Cross Haw to Taiths; here there are no contemporaneous volcanic rocks, but a great sill of felsite, and dykes of mica trap.

3. The Rawthey, Sally Beck and Wandale. In the Rawthey and Sally Beck there are dykes of mica trap and andesite.

4. In Wandale, there are intrusive felsites, and also volcanic ashes.

5. Backside Beck and Cautley. Here the limestones are more conspicuous, and there are numerous felsite sills. The ash beds are dark or yellow, and contain in the upper part calcareous concretions, and pass up into hard, grey, slaty rocks. In the Ashgill shales is a fossiliferous calcareous grit followed by lead-coloured mudstones. All these exposures are more or less connected with the great Dent fault.

The following fossils are recorded from this series:—

Diplograptus pristis.
Favosites aspera.
Heliolites interstinctus.
Monticulipora fibrosa.
Glyptocrinus basalis.
Myelodactylus sp.
Calymene brevicapitata.
Homalonotus bisulcatus.
Phacops Brongniarti.
——— conophthalmus.
——— obtusicaudatus.
Trinucleus seticornis.
——— concentricus.
Phyllopora Hisingeri.
Chonetes minima.
——— sericea.
——— transversalis.
Meristella crassa.
Orthis actoniæ.
Orthis biforata.
——— calligramma.
——— crispa.
——— elegantula.
——— flabellulum.
——— hirnantensis.
——— porcata.
——— protensa.
——— sagittifera.
——— testudinaria.
——— vespertilio.
Strophomena rhomboidalis.
——— expansa.
——— grandis.
——— pecten.
——— siluriana.
Pterinæa tenuistriata.
Tentaculites annulatus.

The Upper Silurian comprises the Stockdale Shales, the Coniston Flags, the Coniston Grits, and the Bannisdale Slates.

1. *The Stockdale Shales* comprise the graptolitic mudstones,

or Skelgill beds, and the pale slates, or Browgill beds. The mudstones may be 100 ft. in thickness, but the line of separa tion of this group from the pale slates is entirely palæontological. The pale slate shows only a little bedding, and is so hard and compact as to simulate a felsite. The most complete section is in Spengill, the account of which is quoted from Marr and Nicholson, Q.J.G.S., vol. xliv. They are seen also in Stockless Gill, Watley Gill, Wandale Beck, the Rawthey, Taiths Gill, Birk's Field Beck, Whinny Gill, and Hebblethwaite Gill. They are crossed by dykes of minette, felsite, and diabase.

The fossils recorded are :—

Climacograptus normalis.	**Monograptus priodon.**
Monograptus revolutus.	**Dimorphograptus confertus.**
——— tenuis.	**——— Swanstoni.**
——— attenuatus.	**Rastrites peregrinus.**
——— Sandersoni.	**——— urceolus.**
——— fimbriatus.	**——— distans.**
——— gregarius.	**Diplograptus vesicularis.**
——— triangulatus.	**——— modestus**
——— spinigerus.	**——— sinuatus.**
——— distans.	**——— Hughesii.**
——— leptotheca.	**Petalograptus palmeus.**
——— lobiferus.	**Retiolites obesus.**
——— jaculum.	**——— Geinitzianus.**
——— turriculatus.	**Cyrtograptus spiralis.**
——— Hisingeri.	**Phacops elegans.**
——— pandus.	**Cheirurus bimucronatus.**
——— griestonensis	**Illænus Bowmanni.**
——— exiguus.	**Leptæna quinquecostata.**

2. *Coniston Flags.*—These are finely striped, or laminated, of dark lead-blue tint, with calcareous concretionary bands. They are very much cleaved. They are seen in Hebblethwaite Gill, and Cross Haw Beck; also at Wandale Hill, Basleside Beck, and Spen Gill.

The fossils recorded are :—

Monograptus colonus.	**Cyrtograptus Murchisoni.**
——— priodon.	**Cardiola interrupta.**
——— sagittarius.	**Orthoceras subundulatum.**
——— turriculatus.	

3. *Coniston Grits.*—These come on gradually. They consist of upper and lower micaceous grits, with a middle non-micaceous thin-bedded grit. The total thickness may possibly reach 3,000 ft. This group occupies the high ground south of Ravenstone Dale, and the foot of Cautley Valley, and the Cautley, Yarlside, and Kensgriff Crags. They also occur at Grere Fell and Harter Fell and Knott. The only fossils recorded are—

Monograptus colonus.	**Cardiola interrupta.**
Rhynchonella nucula.	

4. *Bannisdale Slates.*—These are olive-coloured mudstones, grits, and occasional conglomerates. They run eastwards across the district, in a $\frac{3}{4}$—$\frac{1}{4}$ mile belt, from Dale Gill to Ellergill. At Greenside Gill the following are recorded :—

Chonetes striatella.	Rhynchonella nucula.
Orthis elegantula.	Cornulites serpularius.

81. Nicholson, H. A., and Marr, J. E.—The Cross Fell Inlier.

Quart. Journ. Geol. Soc., vol. xlvii., p. 500, pl. xvii.

This oft-described inlier is bounded by an "escarpment fault" and an "outer Pennine fault," and divided lengthwise by a "Knock Pike Flagdaw fault."

On the east side of the latter all the rocks belong to the Skiddaw slates, and comprise, in ascending order—greenish slates, Ellergill beds, Milburn group. There is also an isolated mass of "Eycott" lava, some intrusive felsite, and diabase, and a mica-trap dyke of great metamorphosing power.

On the west side the surface is cut up by N.E.—S.W. faults into several distinct areas. The most complete section is west of Knock Pike. It commences with rhyolite, and there follow nodular calcareous shales, called "*Corona*-beds"; then the Dufton shales; a limestone with green shales, called "*Staurocephalus* Limestone"; blue Ashgill shales; Stockdale shales and Coniston Flags. The next area, west of Dufton Pike, is much disturbed, but shows the Corona-beds, Dufton shales, and a patch of Staurocephalus limestone. In the next patch comes a thickened mass of Keisley limestone, bounded by faults; and further south the Knock Pike fault passes under the undisturbed conglomerate of Roman Fell, proving its pre-Carboniferous age. Coniston grit occurs on the extreme north.

The following fossils are recorded :—

From the *Corona*-beds :—

Conchicolites gregarius.	Strophomena grandis.
Beyrichia Wilckensiana.	Trematis corona.
Primitia semicircularis.	Ambonychia gryphus.
Homalonotus rudis.	Bellerophon acutus,
Lingula tenuigranulata.	——— bilobatus.
Orthis testudinaria.	Actinoceras pusgillense.

This fauna differs from that of the Coniston limestone, or that of any British group; but is comparable with that of the *Beyrichia* limestone, and Trenton limestone.

From the Dufton shales :—

Dicellograptus complanatus.	Remopleurides Colbii.
Diplograptus socialis.	Trinucleus concentricus.

Diplograptus truncatus.	Trinucleus seticornis.
Amphyx tetragona.	Youngia trispinosa.
Calymene senaria.	Leptæna sericea.
Cybele Loveni.	——— transversalis.
——— verrucosa.	Lingula ovata.
Homalonotus bisulcatus.	Orthis biforata.
Illænus Bowmanni.	——— testudinaria.
Lichas laxatus.	——— vespertilio.
Phacops Brongniarti.	Strophomena expansa.

These represent the Coniston limestone, and the Trinucleus shales of Sweden.

An amended list from the Keisley limestone is:—

Primitia Maccoyii.	Sphærexochus calvus.
Ampyx tremidus.	Atrypa expansa.
Cheirurus bimucronatus	Orthis Actoniæ.
——— cancrurus.	——— porcata.
——— clavifrons.	——— testudinaria.
Cyphaspis triradiatus	——— vespertilio.
Cypheniscus socialis.	Strophomena corrugatella.
Homalonotus punctillosus.	——— deltoidea
Illænus Bowmanni.	——— expansa
——— conifrons.	——— rhomboidalis
Lichas laciniatus.	Loxonema obscura
——— laxatus.	Orthoceras elongatocinctum
Remopleurides longicostatus.	

This is essentially a Coniston limestone fauna.

From some beds in the north of the inlier are recorded—

Praspora Grayæ.	Lingula tenuigranulata.
Callopora pillula.	Orthis elegantula.
Amphion pauper.	——— plicata.
Cyphaspis megalops.	——— testudinaria.
Trinucleus seticornis.	Triplesia spiriferoides.
——— Goldfussi.	Strophomena rhomboidalis.

which are about the horizon of the Corona beds.

The plate is a map of the district, on a scale of 1 inch to the mile, with a section.

82. Forsyth, D.—The Geology of the Carsphairn District of Kirkcudbrightshire.

Leeds Geological Assoc., Nov. 19. (Printed in "Leeds Mercury," Nov. 28.)

The west part of the area has been mapped out by means of its graptolites; but on the east there is a singular absence of fossils in the Black Shales, which he has searched for years. At Knockingarrock, however, they are remarkably abundant. The shales form an anticlinal, so that the Carsphairn grits are the lowest beds in the area.

***83. Kinahan, G. H.—On the Killary Bay and Slieve Partry Silurian Basin; also Notes on the Metamorphic Rocks of North-West Galway (Yar-Connaught).**

Proc. Roy. Irish Acad., 3rd series, vol. i., p. 705.

The Silurian basin of Slieve Partry has been said to have a mythical northern boundary, and to really pass into the Ordovician. The author states that the conglomerates at the base contain pebbles of the northern rocks, such as the pebbly sandstones of Westport, and quartzose grits of Erriff. The trap dykes, &c., also come up to the Silurian and stop. East of Doolough, the older rocks are on edge, and the Silurians are horizontal. The fossils of the Salrock promontory, between Great and Little Killary, are of Ordovician type, while those of the adjacent Salrock slates are of Silurian and littoral.

He cannot agree that the (Yar Connaught) rocks are Archæan, simply because of the hummocky character of the ground—which is found equally in rocks of several ages. Nor does he believe that the "eyes" in the hornblende schists are due to shearing, as the matrix graduates into a micaceous, felsitic, or quartzitic one; and also because in non-metamorphic areas there are similar, *i.e.*, nodular, "adjuncts of whinstones," and instances the Great Rock, Arklow, as one in which whinstone passes through conglomerate into sedimentary rock, and considers the nodular and schistose hornblende rocks "baked argillaceous rocks subsequently metamorphosed," and the eyes relics of conglomerates.

A digression is then made about Sutherlandshire, on which generally he refuses to believe most of what the "Shearers" assert.

The rocks of Connemara have been stated to show no conglomerates, sandstones, or shales, nor any materials that might be supposed to represent such rocks in a metamorphosed condition. This statement, the author says, is due to simple want of observation. The Galway type of granite is asserted to pass through gneiss into schists, and is therefore called metamorphic granite. He then gives proofs that the Galway rocks south of the Clifden and Oughterard road are mostly altered sediments, viz., in the north there is a limestone and schist series with subordinate quartzite, and the same series occurs in all the different sections—proving original deposition. In the limestones there are chertz and shaly layers—and the other appearances may be illustrated by what is seen in a sack of "spoiled" cement. The "nodules and lentils of endogenous granite" are not pebbles or sheared veins. The Connemara serpentine may be seen in the Lesoughter quarries to have been changed from dolomites or dolomitic limestones.

He is willing to leave it doubtful if the Bennabeola rocks are really the oldest, as there may be unrecognised uncon-

formities—still the sequence N., E., or S., from thence is the same. In any case the Lough Conga conglomerate is derived from these older rocks. As the rocks of West Galway are of uncertain age he calls them *Connemarians*, and those south of Clew Bay the *Umalians*. It is these Umalians that have been said to be sheared Silurians—but he says they are Ordovician by their fossils.

***84. Hicks, H.—A Comparison between the Rocks of South Pembrokeshire and those of North Devon.**

Geol. Mag., Dec. 3, vol. viii., p. 500. (Abstract of Paper read at the British Association, Aug., 1891.)

Near Johnston and Stoney Slade the basal Upper Silurian conglomerate lies unconformably on all below, but from this to the Carboniferous there is no marked break in the series, but all are folded together with a W.N.W. strike. The succession and folding are so similar in North Devon that he is convinced that the beds in the two areas were deposited contemporaneously in one continuous area.

***85. Morgan, J. B.—On the Strata forming the Base of the Silurian in North-East Montgomeryshire.**

Montgomeryshire Collections, vol. xxv., p. 359. Rep. Brit. Assoc. for 1890, p. 816.

Between the towns of Welshpool and Llanfyllin there is a band of quartzose grit, sometimes a coarse purple conglomerate, striking N.E. and S.W. The pebbles are sometimes obtained from the underlying rock; the whole is red, and graduates upwards into fine-grained sandstone. They repose transgressively on different zones of the underlying Ordovicians, and contain the following May Hill fossils:

Pentamerus oblongus.	Pentamerus undatus.	Stricklandinia lirata.
Atrypa marginalis.	Petraia bina.	

They pass upwards into Wenlock shale, and thus are not Caradoc sandstone as mapped by the Geological Survey, but basement beds of the Silurian, which here, as elsewhere, is unconformable to the Ordovician.

***86. Watts, W. W.—The Geology of the Long Mountain on the Welsh Borders.**

Rep. Brit. Assoc. for 1890, p. 817.

This range is a large faulted syncline with a steep dip on the N.W. side. It consists in ascending order of the following:—

1. May Hill Grit and conglomerate resting unconformably on Bala, with a fossiliferous limestone at Cefn.
2. Purple and green shales, with few fossils.
3. Wenlock Mudstones, more calcareous above, with

Cyrtograptus Linnarssoni, *Monograptus Flemingii*, *M. dubius*, and *M. serra* (= Wenlock shale and limestone).

4. Thin muddy shales with *M. colonus*, *M. Nilssoni*, and *Cardiola interrupta* (= Lower Ludlow).

5. Hard thick shales, and shales with *Monograptus leintwardinensis*, *M. Salweyi*, and *M. Rœmeri* (= Aymestry).

6. Thin fissile shales (= Upper Ludlow) with an outlier of Passage beds.

DEVONIAN.

*87. Ussher, W. A. E.—The Devonian Rocks, as described in De la Beche's Report, Interpreted in Accordance with Recent Researches.

Rep. Brit. Assoc. for 1890, p. 801, and Cornwall Royal Geol. Soc., vol. xi., p. 273.

The description given by De la Beche for North Devon and West Somerset still holds good, but in South Devon allowance was not made for the now proved disturbances, so that rocks repeated by plication were taken for successive horizons, and the Ashprington series was overlooked. As to Cornwall, he had insufficient materials, and made no allowance for inverted junctions. At present the author gives a tentative classification of the Cornish rocks as follows:—

Upper Devonian.—Tintagel and Petherwin series, with contemporaneous Volcanic rocks.

Middle Devonian.—Grey slates, with occasional limestone bands, Pemuzar Bay, Mount Edgecumbe.

Lower Devonian.—Upper Coblenzian = S. Breoc Down, Picklecombe grits; Lower Coblenzian = Mawgan slates, Tregantle limestone, and Newquay slates?; Hunsrückian = S. Austell slates; Upper Gedinnian = Looe Beds, Black Head, &c.; Lower Gedinnian = Grampound and Newlyn Down arenaceous rocks.

South of this the grouping may be possibly inverted.

The correlations of these rocks with the Devonshire ones is *suggested* as follows:—

CORNWALL.	S. DEVON.	N. DEVON.
S. Breoc's, Down, and Boconnoc grits.	Staddon, Modbury, Cockington, &c.	Hangman group.
Newquay and Mawgan Slates, and Tregantle Limestone.	Meadfoot Beds.	Lynton Beds.
S. Austell and Watergate Bay variegated slates.	Dartmouth & Kingswear Slates.	Foreland grits.
Looe Beds.	(Not identified.)	Possibly part of Foreland grits.
Grampound and Newlyn Down rocks.	? Present.	? Present.

By means of the descriptions and localities mentioned in De la Beche's report, maps are made of North Devon and Cornwall showing the distribution of the subdivisions; that of the former accords fairly with their known distribution, the latter is a *terra incognita* to geologists.

***88. Ussher, W. A. E.—Vulcanicity in the Lower Devonian Rocks. The Prawle Problem.**

Geol. Mag., Dec. 3, vol. viii., p. 511. (Abstract of paper read at the Brit. Assoc. in Aug., 1891.)

[The chloritic and mica schists to the north of Prawle Point have been considered by some to be metamorphosed Devonian, but more recently they have been described as Archæan by T. G. Bonney, Quart. Journ. Geol. Soc., vol. xl., p. 1.] The author goes back to the other view on the following grounds. The absence of any evidence of fault or unconformity between the Devonian rocks on the north and the metamorphosed rocks on the south. The recurrence through folding of volcanic rocks in the Devonian which in the latitude of Torcross present a chloritic aspect. The similarity of succession between the Devonian volcanic rocks and phyllites and the chloritic and mica schists. The lithological similarities between the altered and unaltered sediments.

OLD RED SANDSTONE.

***89. Evans, J. W.—The Geology of the North-East of Caithness.**

London: Dulau and Co., 8vo, pp. 48, with map and sections.

This deals with the Old Red Sandstone. First the varieties, as flags, fine-grained calcareous, fissile, and massive sandstones are defined, and then follows a detailed account of the succession, with dip and faults, anticlinals and synclinals, commencing on the south at Noss Head, along the coast line, with the corresponding inland exposures, to Duncansby Head—all of which may be followed by aid of the accompanying map. The massive sandstone south of the Head is then traced across to John o' Groat's House, and finally the description of the northern coast as far as Barrogill Castle is given.

The classification of these rocks is next considered, particularly that by Sir A. Geikie (Trans. Roy. Soc. Edinburgh, vol. xxviii.), in which the east coast series is considered to be on the whole an ascending one from south to north, and to lie entirely below the north coast series, which is considered an

ascending one from west to east, while the author considers the two series as nearly contemporaneous. Against the thicknesses there assigned he brings arguments of dip, and explains the different character of the northern series by its being more remote from land except round ancient islands. The Palæontological argument for the younger age of the northern series, he attacks by denying that *Dipterus Valenciennesii* and *Osteolepis arenatus* are really peculiar to the eastern series, and by accounting for the absence of Acanthodeans in the eastern series, by the possible unsuitability of the environment, and by their presence at Achanarras (considered to belong to the eastern portion).

He then takes a point, Slickly, nearly equidistant from the north and east coasts, and shows by dips that the beds there are 4,300 ft. below those of Sinclair Bay, and about 6,000 ft. below the highest beds on the east coast at Latheron, and as by the same method they are only 7,700 ft. below the beds on the north at Huna, the two series must to a large extent be the same, though the rocks at John o' Groat's are higher than all. The general result of this contention is that the total thickness of the deposits in this area is much less than has been supposed.

The second part of the paper combats the view of Sir A. Geikie that these Lake Orcadie beds are of the age of the Lower Old Red Sandstone. He first explains away the difficulties adduced in the way of assigning them a later age—and then enters the main argument against the peculiar fauna being merely due to special conditions. A table is given of all the genera and species hence recorded, with their relations to other fauna, and also a list of 74 papers bearing on the subject. Out of the 30 fish, six occur in the Upper Devonian of Russia or Upper Old Red of Ireland, and only one doubtful one in the Lower Old Red of Scotland; of the 18 genera 11 occur in Upper Devonian or Upper Old Red, and only three in the Lower, two of which pass into the Upper; only two families (Coccosteidæ and Acanthodidæ) are common to the Lower Old Red, while all pass to the Upper. Among crustacea, *Estheria* commences here. The plants are more doubtful, but on the whole show Upper Old Red alliances. These differences are too great to be accounted for by isolation and special conditions—especially as the forms of the Lower Old Red have a wide range. The author is therefore inclined to class these beds as a lower portion of the Upper Old Red Sandstone under the title of Orcadian, the ordinary Upper Old Red types belonging to the higher zone of *Bothriolepis*.

***90. Hull, E., &c.—Explanatory Memoir to accompany Sheets 3, &c.**

Mem. Geol. Surv. Ireland, chap. v. [*see* No. **71**].

In the Fanad Promontory, Donegal, is the following succession:—

(*a*). Red Sandstone and conglomerate dipping at about 5°—10° to S.E.
(*b*) Chocolate-coloured, thin-bedded sandstones, sometimes false-bedded with a little conglomerate.
(*c*) Strata, principally of red sandy shales.
(*d*) Purplish-brown sandstone and conglomerate.

The total thickness is probably 700—800 feet. The pebbles are of local origin, and the whole is so like the Scottish Old Red Sandstone that they must almost certainly be of the same age.

CARBONIFEROUS.

***91. Morton, G. H.—The Geology of the Country around Liverpool, including the North of Flintshire. 2nd Edition.**

London: Philip and Son, 8vo, pp. 287, 20 plates.

The lowest beds are seen in Flintshire.

CARBONIFEROUS LIMESTONE.—This is divided into Upper Black Limestone 200 ft., Upper Grey Limestone 500 ft., Middle White Limestone 600 ft., Lower Brown Limestone 400 ft., and Red Basement beds. They dip N. from Bryniau Uchaf to Prestatyn, but they are cut off abruptly on the strike, 204 ft. of sand having been sunk through without reaching rock.

The Red basement beds are not much exposed on the surface.

The Lower Brown Limestone contains foraminifera, calcisphæra, and encrinites.

The Middle White Limestone is very massive and unbedded, with many foraminifera and calcareous algæ? It is much faulted, and is fossiliferous at Graig Fawr.

The Upper Grey Limestone is thin bedded. Specimens from Gwaenysgor are beautiful microscopic objects containing foraminifera, crinoid joints, oolite grains with *Girvanella Ducii*, &c. It is fossiliferous at Prestatyn, Gop Hill, Newmarket, and Axton.

The Upper Black Limestones are fine grained and thin bedded, with shale partings, whence plants have been obtained at Teilia.

The following fossils are recorded from this district in (1) the Upper Black, (2) Upper Grey, (3) Middle White, (4) Lower Brown Limestone:—

Cladodus sp., 1.
Orthoceras, sp. nov., 2.
Productus punctatus, 2, 3, 4.
——— pustulosus, 2.

Nautilus planotergatus, 2.
Goniatites sphericus, 2.
———— bilinguis, 1.
Buccinum rectilineum, 2.
Euomphatus Dionysii, 2, 4.
———— tabulatus, 4.
———— pentangulatus, 2, 3.
———— pileopsideus, 3.
Littorina sp. nov., 2.
Macrocheilus imbricatus, 2, 3.
Natica ampliata, 2.
Nerita spirata, 2, 3.
Pleurotomaria rotundata, 2, 3.
Porcellia puzosi, 2, 3.
Straparollus costellatus, 2.
Ambonychia undata, 2, 3.
Aviculopecten papyraceus, 1.
———— circularis, 2.
———— fimbriatus, 2.
———— planoradialis, 3.
Posidonomya Becheri, 1.
———— Gibsoni, 1.
Edmondia unioniformis, 2, 3.
Myacites sulcata, 3.
Pinna flabelliformis, 3.
Athyris expansa, 2.
—— planosulcata, 2.
—— Roissyi, 2.
Discina nitida, 2.
Orthis Keyserlingiana, 2.
—— resupinata, 2.
Chonetes papilionacea, 2, 3, 4.
Productus aculeatus, 2.
———— cora, 2, 3, 4.
———— costatus, 2.
———— fimbriatus, 2, 3.
———— giganteus, 2, 3, 4.
———— latissimus, 2.
———— longispinus, 2, 3.
———— margaritaceus, 3.
———— plicatilis, 2.
Productus scabriculus, 3.
———— semireticulatus, 2, 3.
———— striatus, 2, 3.
Rhynchonella acuminata, 2.
———— angulata, 3.
———— pleurodon, 2, 3.
———— pugnus 2.
Spirifera bisulcata, 2, 3.
——— convoluta, 2.
——— cuspidata, 2.
——— duplicicosta, 2.
——— elliptica, 4.
——— glabra, 2, 3.
——— grandicostata, 2.
——— integricostata, 2.
——— pinguis, 2, 3.
——— lineata, 2, 3, 4.
——— ovalis, 2.
——— striata 2, 3.
——— subconica, 2, 3.
——— triangularis, 2.
Spiriferina insculpta, 2.
Streptorhynchus crenistria, 2, 3, 4.
Terebratula hastata, 2, 3.
Fenestella plebeia, 2.
Griffithides seminiferus, 2, 3.
Poteriocrinus crassus, 2.
Amplexus coralloides, 2.
Syringopora geniculata, 2.
Lithostrotion Martini, 2.
Zaphrentis Griffithi, 2.
———— cylindrica, 4.
Asterocalamites scrobiculatus, 1.
Adiantites antiquus, 1.
Rhacophyllum flabellata, 1.
———— inæquilatera, 1.
Sphenopteris subgeniculata, 1
———— Teiliana sp. nov., 1.
———— pachyrrachis, 1.
———— Schlehani, 1.

The Cefn-y-Fedw Sandstone may be the equivalent of either the Yoredale shales or the Millstone Grit. It is divided into Gwespyr Shale 150 ft., Gwespyr Sandstone 120 ft., Holywell Shale 100 ft., and Cherty Sandstone 250 ft., in descending order.

Only 100 ft. of the Cherty Sandstone is exposed on the surface, but a shaft at Talacre passed through 300 ft. of chert dipping at 15°. It is sent to the potteries for floors, and contains sponge spicules. The interstratified shale yields *Chonetes hardrensis* and *Productus longispinus*. The Holywell Shale has yielded *Posidonomya Gibsoni* at Talacre, and *Aviculopecten papyraceus* at Holywell. Quarries are worked in the Gwespyr Sandstone which contains *Sigillaria reniformis*, there are interbedded shale bands, and curious sandstone

concretions. It is used as a building stone. The Gwespyr Shale is seen in Dingle; it is of a peculiar greenish tint, and may be on the horizon of the Lower Coal-measures of Lancashire.

The Lower Coal-measures are not exposed on the surface in Flintshire, but have been met with underground at Talargoch and Meliden. The middle coals have been worked at Mostyn, and are still worked at Neston, of which a section is given showing several faults. The general succession is: Strata 146 ft., coal 4 ft.; strata 105 ft., coal 3 ft.; strata 47 ft. 6 in., coal 6 ft.; strata 164 ft., coal 5 ft.; strata 51 ft., coal 7 ft. 6 in.; strata 78 ft., coal 2 ft. It is impossible to correlate these with the other Flintshire coals.

The Millstone Grit is only exposed in isolated areas near Liverpool, viz., in Knowsley Park, Grimshaw Delf, and at Parbold and Harrock Hills.

The Coal-measures round Prescot, &c., he estimates at: Upper 1,200 ft., Middle 1,300 ft., Lower 1,880 ft.; of these a section is given in Plate IV. The Lower Coal-measures are little seen—but best at Pimbo Lane and Billinge Hill, where there are concretions, also *Goniatites Listeri* and *Aviculopecten papyraceus*. The only important coals are the Upper Mountain Mine 2 ft., and the Lower 2 ft. 8 in. Comparative general sections from published memoirs are given of the Middle Coal-measures, showing at Prescot 1,320 ft. with 14 beds of coal 61 ft. in all; at St. Helen's 1,739 ft., with 19 coals, 84 ft. in all; and at Wigan 2,179 ft., with 17 coals, 72 ft. in all. A list is then given of the plants from Ravenhead [see No. **492**, 1890]. The best place for seeing the Middle Measures is Thatto Heath. Fish bones and scales (eight named) were here found. At Doulton's Delf,[1] St. Helens, a section is seen which has yielded 22 plants, all included in the Ravenhead list. The best section of the Upper Coal-measures is in the cutting between Rainhill and Marshall's Cross stations—they are quite unproductive.

92. Russell, R.; Strahan, A.; Clough, C. T.; Barrow, G.; Dakyns, J. R.; Tiddeman, R. H.; De Rance, C. E.—The Geology of the Country around Mallerstang.

Mem. Geol. Survey., chapters iv.–xi.

The description of the Carboniferous Limestone series is given according to districts.

1. *The South Western corner of the Map* (97 N.W.)—Here the

[1] "Delf" in Lancashire means any place that is dug or delved, *e.g.*, a quarry.

beds are greatly affected by the Dent fault; but the basement beds occur on the west side of it. They are best seen in Hebblethwaite Gill, and die out northward. They consist of red coloured conglomerate, the pebbles being of the underlying Silurian rocks, but not of Lake District rocks, nor of quartz. They lie unconformably on the Silurian, and are followed, on the west side of the fault, by Lower Limestone shales.

The general classification of the Carboniferous Limestone series in this memoir is:—[1]

Yoredale Rocks	———
	Ganister-like Sandstone.
	Fell Top Limestones.
	The Crow Chert and Limestone.
	The Ten fathom Grit.
	———
	The Little Limestone.
	———
	The Main Chert and Limestone.
	———
	The Underset Limestone.
	———
	The Three yards Limestone.
	———
	The Five yards Limestone.
	———
	The Middle Limestone
	———
	The Simonstone Limestone.
	———
	The Hardraw Scar Limestone.
Great Scar Limestone Series	The Melmerby Scar Series.
	The Ash Fell Beds.
	The Ravenstonedale Limestone series.

The Dent fault brings down these against the Coniston Flags, revealing only a portion of the Great Scar series. The fault is reserved, hading under the Coniston Flags. Near Hebblethwaite Hall it leaves the basement beds curving down to it on the west, and the Carboniferous Limestone series bend round like a crook on the east. Various sections of the members of the Yoredale series are given in the Clough, Dove Cote Gill, Penny Farm Gill, Nor Gill, Whinny Gill, Gutter Scales, Taiths Gill and Blue Caster, where inverted strata are seen near the Dent fault; the Rawthey where numerous exposures give a very complete sequence; and Needle-house Gill, showing all the strata from the Five-yards to the Simonstone Limestone.

2. *Garsdale and Grisdale.*—The section in Garth Gill goes from

[1] ——— = Shales, sandstones, &c.

the Simonstone to the Five Yard. In Swarth Gill the Underset is seen, which at Greenside is worked as "Black Marble." These limestones are followed round the hills by means of their "swallow holes." The strata between the Main and Underset are 80 ft., including an 8 in. bed of coal. In Grinning Gill the highest beds are seen down to the Underset. In Grisdale Beck, the strata above the Main are 200 ft., including another 8 in. coal. In the Rawthey Valley, 120 ft. below, the Little Limestone is measured. These beds form a link between the Swaledale type and the more coal-bearing type of the North.

3. (*a.*) *Ravenstonedale and Upper Eden Valley.*—In Pinskey Gill 66 ft. of Lower Limestone shale are seen resting directly on the Silurian—not separated by a fault as previously supposed. It is in this district that the development of the Great Scar Limestone series, as above given, is best seen. In the lower beds quartz-pebbles are seen. In the Ashgill series are intercalations of thick beds of sandstone. The Yoredale series, with the worked Underset coal, are well seen in Reigill, Hartley Fell, where the Main Limestone is 60 ft. thick. In the ridge of Great Bell eight limestones are seen, and the lower part of the series in Jancey Wood; but the best section is seen on the Midland Railway south of Birkett Tunnel, 838 ft. being described in 88 subdivisions. A comparison of this with the other sections not far off shows how variable the beds are.

3. (*b.*) *Mallerstang.*—The beds here described belong to the Yoredale series, but no special sections are described.

4. (*a.*) *The Valley of the Ure* (*Wensleydale*).—This is the typical district of the "Yoredale beds" described by Phillips, and a general section is given from the Main Limestone downwards to the Great Scar. The coal below the Middle Limestone has been recently worked near Mease Gill. The Underset and Main Limestone make everywhere splendid escarpments. In tracing the Main, from the watershed down the Ure Valley, it is found to rise irregularly from 1,250 to 1,650 ft.

4. (*b.*) *The Watershed between Wensleydale and Swaledale.*—In this area the uppermost beds are mainly described, viz., those on either side of the Ten-fathom Grit.

5. *Swaledale.*—This district is somewhat complicated by an east and west metalliferous fault known as the Stockdale Fault. The lowest limestone visible is the Hardraw Scar, and the exposures of the overlying beds are traced at various spots. An average section is given from the Main Limestone downwards, showing 980 ft. in 24 divisions. The beds called the "Red and Black Beds" come immediately above this—the former are decayed crinoidal limestones, the latter chert.

The higher beds between the Ten-fathom Grit and the Millstone Grit are variable. Towards the south the thickness is generally less than 50 ft., and in Lower Gill only 3½ ft. Yet in the northern part, in Stonesdale, a section gives 242 ft. in nine subdivisions, which are considered to be new beds. They include two Fell-top Limestones. The best exposure of the Crow Limestone is in Mould Gill.

6. *Arkendale.*—A section seen in a shaft at Wet Shaw is first given. It shows the strata from the Millstone Grit down to the Three Yard Limestone. The beds above the latter amount to 689 ft. in 37 subdivisions. Of this, 134 ft. lie above the Chert Limestone, and no record of the Little Limestone is made, and there are 28 ft. of beds between the Main Limestone and the Red and Black Beds. A section of the Lower bed is given in Punchard Gill. The beds above the Little Limestone in Annaside Beck comprise some "wormy grits," so-called from the number of their fucoid markings. Sections are also given here of the beds between the Ten-fathom Grit and the Fell Top Limestones, the richest in limestones being in Great Punchard Gill.

7. *Birkdale, and the Upper Part of the Basin of the Swale.*—The succession here is much obscured, but details are given of beds above the Ten-fathom Grit.

The following is a list of the specifically-named fossils recorded from this series. (1) = Great Scar Limestone; (2) = Yoredale Beds; (3) = Ditto above the Main Limestone, and formerly classed with the Millstone Grit:—

Stigmaria ficoides, 2.
Alveolites septosa, 1, 2.
Amplexus coralloides, 1.
Aulophyllum fungites, 2.
Cyathophyllum regium, 2.
Lithostrotion junceum, 1, 2.
———— Martini, 1.
———— irregulare, 1, 2.
Syringopora ramosa, 2.
Zaphrentis Phillipsi, 2.
Serpula parallela, 3.
Griffithides globiceps, 2.
Fenestella plebeia, 1, 2.
———— multiporata, 2.
Polypora laxa, 2.
Rhombopora multangularis, 2.
Athyris ambigua, 1, 2.
———— expansa, 2.
———— Royssii, 1, 2.
Camarophoria globulina, 2.
Chonetes Buchiana, 2.
———— laguessiana, 2.
———— papilionacea, 2.
Cyrtina septosa, 1.
Spirifera grandicostata, 2.
———— lineata, 2.
———— ovalis, 2.
———— pinguis, 2.
———— striata, 2.
———— triangularis, 2.
———— trigonalis, 1, 2.
Spiriferina laminosa, 1, 2.
Streptorhynchus crenistria, 1, 2, 3.
Strophomena rhomboidalis, 1, 2.
Terebratula hastata, 1.
Aviculopecten arenosus, 2.
———— asperulus, 2.
———— dissimilis, 2.
———— fimbriatus, 2.
———— interstitialis, 2.
———— knockonensis, 2, 3.
———— micropterus, 2.
———— tessellatus, 2.
Pecten Sowerbyi, 2.
Pinna flabelliformis, 2, 3.
Posidonomya vetusta, 2.
Pteronites persulcata, 2.
Arca semicostata, 2.

Discina nitida, 2, 3.
Lingula Credneri, 2, 3.
——— myliloides, 2.
——— squamiformis, 2.
Orthis Michelini, 1, 2.
——— resupinata, 2.
Productus costatus, 1, 2.
——— fimbriatus, 1, 2.
——— giganteus, 1, 2.
——— llangollensis, 1.
——— latissimus, 2, 3.
——— longispinus, 2.
——— margaritaceus, 1.
——— punctatus, 1, 2.
——— pustulosus, 1.
——— scabriculus, 2.
——— semireticulatus, 1, 2.
——— undiferus, 2.
——— Youngianus, 1.
Rhynchonella pleurodon, 1, 2.
Spirifera convoluta, 2.
——— duplicicosta, 1.
——— glabra, 2.
Cardiomorpha Egertoni, 2.
Cypricardia modiolaris, 2.
Dolabra inequilateralis, 2.
Leda attenuata, 2.
Lithodomus Jenkinsi, 2.
Sanguinolites angustatus, 2.
Cylindrites carbonarius, 1.
Eulima Phillipsiana, 1.
Euomphalus acutus, 1.
——— calyx, 1.
——— carbonarius, 1, 2, 3.
——— Dionysii, 1.
——— quadratus, 1.
Loxonema rugifera, 1, 3.
——— scalarioidea, 2
——— sulcatula, 2.
——— ventricosa, 1.
Dentalium priscum, 2.
Bellerophon hiulcus, 2.
Conularia quadrisulcata, 2.
Discites subsulcatus, 2.
Goniatites bilingua, 2.
Psammodus rugosus, 1.

The Millstone Grit.—The general development of this is given as consisting of five grits with intervening shales—the lowest being the Ingleborough grit—and the total thickness is over 550 ft. The rocks of this group all occur in outliers, mostly forming the summits of the various fells. In Baugh Fell 500 ft. are seen, the base being a pebbly grit overlaid by a coal seam. Baugh Fell, Wild Boar Fell and Little Fell show a similar sequence to the second grit. Mallerstang edge is formed by the fourth grit—which is overlaid by thin crinoidal limestones and shales. The coal near the base, 300 ft. below the top, is worked at Blue Gill and called the Fells End seam. On Shunner Fell the greatest thickness is seen. Here the grits make good features; the most conspicuous being Pickersett Edge, made of the fourth grit. Here only is found the fifth or highest grit, beneath which are thin fossiliferous limestones, with a Trilobite, *Orthis resupinata*, *Rhynchonella pleurodon*, *Streptorhynchus crenistria*, and *Orthoceras*. Muker Common shows the Tanhill coal above the first grit. The same is seen in Raven Seat, some flags below the second grit being called the "Fossil Grit." The Tanhill coal is also seen in Great Punchard Head, which is worked in a small area round Tanhill. It is, however, split up by shales, and below is a fireclay. The other outliers are also described, some only reaching the first grit.

93. Harker, A.—The Basement Conglomerate of the Carboniferous in Westmoreland and Yorkshire.

"The Naturalist" for 1891, p. 38.

The pebbles at Hutton consist mostly of Lake District

igneous rocks and Coniston Limestone of the Keisley type. In Hebblethwaite Gill the pebbles are of red stained Coniston Limestone, or like the Ingleton Grit, and a few like the intrusive felsites. Near Shaps Well they are almost all of Shap Granite.

94. Gasking, S.—The so-called "Old Red Sandstone" Formation of the Isle of Man.

"Yn Lioar Manninagh," vol. i., p. 135.

Confirms the correlation of these beds at Langness and Peel with the Calciferous Sandstone series, and the denial of their giving any evidence of glacial action in Carboniferous times.

***95. Dakyns, J. R.—On the Changes of the Lower Carboniferous Rocks in Yorkshire from South to North.**

Rep. Brit. Assoc. for 1890, p. 811; and Proc. Yorks. Geol. and Polyt. Soc., vol. xi., part iii., p. 353.

The simple fourfold division of the Millstone Grit in Derbyshire becomes complicated further north by the setting in of fresh sandstones. The Yoredale type of rocks can hardly be said to exist south of Kettlewell. From Grassington northwards the Carboniferous Limestone becomes split up by sandstone and shale, in which shales, to the North of Kettlewell, the "Underset" and "Main" Limestones set in, so that finally the Yoredale type appears.

In the southern part of its course the "Main" Limestone is immediately overlaid by Millstone Grit, but northwards a set of cherty beds intervenes, beginning at Coverhead as a thin cherty top to the Limestone, and gradually developing into a complete series composed of chert, sandstone, and shale, known as the "Black and Red Beds" in Swaledale. Further north, these change again into a set of coal-bearing sandstones, grits, and shales, known as the Coal Sills, overlain by a thin but persistent bed of limestone known as the "Little" Limestone.

The most constant line which can be drawn between the Yoredales and the changeable Millstone Grit is at the top of this cherty series and its equivalent the "Little" Limestone.

The siliceous grits and ganister-like beds that occur in the Millstone Grit series above the Kinderscont Grits, become more pronounced northwards, so that at length they are regular ganister measures.

96. Tiddeman, R. H.—Physical History of the Carboniferous Rocks in Upper Airedale.

Proc. Yorkshire Geol. and Polyt. Soc., vol. xi., part iii., p. 482.

The contents of this are practically the same as those of

the author's paper read to the British Association in 1889 [see No. **163,** 1890], with a few more local details in proof of his statements.

97. Craig, R.—Notes upon a Cutting in the New Kilburnie Branch of the Lanarkshire and Ayrshire Railway, on the Farm of Gurdy, Beith.

Trans. Geol. Soc. Glasgow, vol. ix., part i., p. 64.

The strata here shown lie above the main coal of the Dalry Field, and are compared with those previously described in Kerrsland Glen. Beginning at the base are seen :—

Limestone, No. 1, 1 ft. 4 in. thick, shale 28 ft. Limestone, No. 2, 2½ ft., shale 20 ft., sandstone, 3½ ft. Limestone, No. 3, 3 ft.

The principal point of the paper is the record of fossils from these beds. 1 = No. 1, Limestone and Shale; 2 = No. 2, Limestone and Shale; 3 = No. 3, Limestone and Shale.

Tabulipora Urei, 1, 2, 3.
Zaphrentis cylindrica, 2.
Platycrinus lævis, 2, 3.
Poteriocrnius crassus, 1, 2, 3.
Rhodocrinus uniarticulatus, 2.
Serpulites carbonarius, 2.
Spirorbis Armstrongi, 2.
Cythere bairdioides, 1, 2. 3.
Beyrichia subarcuata, 2.
Leperditia Youngiana, 1, 2, 3.
Fenestella plebeia, 1, 2.
Polypora dendroides, 2, 3.
Athyris ambigua, 1, 2, 3.
——— planosulcata, 2.
Discina nitida, 1, 2, 3.
Lingula mytiloides, 1, 2, 3.
Orthis Michelini, 1, 2, 3.
Productus longispinus, 1, 2, 3.
——— plicatilis, 1.
——— scabriculus, 2.
——— semireticulatus, 2.
——— Youngianus, 2.
Rhynchonella pugnus, 1.
Spirifera trigonalis, 1, 2.
Martinia Urei, 2.
Reticularia lineata, 2.
Dielasma vesicularis, 2.
Aviculopecten cœlatus, 2.
——— concentrico-striatus, 1, 2.
——— interstitialis, 1, 2, 3.
——— orbiculatus, 2.
Entolium Sowerbii, 1, 2.
Arca Lacordaireana, 1, 2.
Schizodus carbonarius, 1, 2.
——— deltoideus, 1, 2, 3.
——— centralis, 1, 2.
Cardiomorpha oblonga, 1, 2.
Cypricardia striato-lamellosa, 1, 2, 3
——— rhombea, 1, 2.
Edmondia oblonga, 1, 2.
Leptodomus costellatus, 1, 2.
Nuculina oblonga, 1, 2, 3.
——— attenuata, 1, 2.
Nucula gibbosa, 1, 2, 3.
——— lineata, 2.
Entalis inornatum, 1, 2, 3.
——— priscum, 1, 2.
Polyphemopsis Phillipsiana, 2.
Loxonema Lefebrei, 1, 2.
——— curvilinea, 1, 2.
Macrochilina acuta, 1, 2, 3.
——— fusiformis, 2.
——— Michotiana, 1, 2.
Naticopsis variata, 1, 2.
——— canaliculata, 1, 2.
Natiria lirata, 2.
Tychonia Omaliana, 2.
Aclisina quadricarinata, 2, 3.
Agnesia contraria, 1, 2.
Ptychomphalus monilifera, 1, 2.
Bucania decussata, 1, 2, 3.
Waagenella Dumontii, 2,
Euphemus Urei, 1, 2, 3.
Orthoceras attenuatum, 1, 2.
——— undatum, 2.
——— cylindraceum, 1, 2.
——— Goldfussianum, 1, 2, 3.
Nautilus quadratus, 2.
Cladodus mirabilis, 1.
Tomodus convexus, 1, 2.
Helodus didymus, 1, 2
Petalodus Hastingsiæ, 2.
Megalichthys Hibberti, 1, 2, 3.

98. Wardingley, Chas. — The Carboniferous Limestone of Scotland.

" Science Gossip," pp. 60–64.

In the Forth district there is not above 90 ft. of limestone, including the Burdie-house. It is best seen at Invertill, where it is encrinital and otherwise fossiliferous. At East Lomond Hill it reaches its greatest height above sea-level. At Bathgate the limestone is thickest and very fossiliferous. In the Dumfries district there are quarries at Closeburn, where the limestone is very magnesian; better exposures are seen at New Cummock, where are 70 ft. of rock, very fossiliferous (11 species named); and also at Kellhead about 50 ft.

99. Dairon, J. — The Lower Carboniferous System in Dumfriesshire.

Trans. Dumfries and Galloway Nat. Hist. and Ant. Soc., No. 7, p. 103.

Mountain Limestone is worked at Donkin and Blacketridge and yields: *Productus giganteus*, *P. semireticulatus*, *Gyracanthus*, Coprolites, *Lithostrotion irregulare* and *L. junceum*.

100. Symes, R. G.—Explanatory Memoir to accompany Sheets 31 (in part) and 32 of the Maps of the Geological Survey of Ireland. Chapter V. [Carboniferous rocks near Ballyshannon.]

Mem. Geol. Surv. Ireland.

The *Lower Carboniferous Sandstone* has conglomerates at its base with pebbles of the underlying gneiss. It is used for millstones and flags, and the associated shales yield trilobites. It is seen at Tullylinn Hill, Pettigoe, and east of Laghy.

The *Lower Limestone* consists of grey crystalline limestone interstratified with brownish grey dolomite—the latter having very irregular bedding. Sections are best seen along the River Erne, where the junction with the Archæan is exposed, showing some conglomerate at Cliff. Other exposures are noticed in Brownhall, 2 miles N.E. of Laghy, E. of Belleek, 4 miles N.E. of Pettigoe, and to the N. of Bundoran, where are many fossils.

The Middle (or Calp) Limestone, Shale, and Sandstone.—The upper member is dark earthy carbonaceous limestones and shales; the middle, ferruginous sandstones; the lower, black fossiliferous shales. These are well seen on the coasts S. of Coolmore where they are dipping S. At Kildoney the beds become conglomeratic; at Cool Beg they are worked for building stone. Exposures are noted on R. Erne, east of Belleek, Castle Coldwell, Boa Island, N. of Bundoran, and Bundrowes Bridge.

The *Upper Limestone* caps the cliffs in the Magho escarp-

ment, and is 200 ft. thick, consisting of thick beds of bluish chert and coralline limestone full of microscopic organisms.

The Yoredale Sandstone is massive and yellow, and is well seen on the shores of Lough Erne, dipping S. at 10°.

The following fossils are recorded by **W. H. Bailey.** The localities (72) are given, but not the horizons :—

Sagenaria veltheimiana.
Amplexus coralloides.
Chætetes tumidus.
Cyathophyllum ceratites.
——— cylindrica
Favosites parasitica.
Lithodendron affine.
——— junceum.
Michelinia favosa.
Syringopora geniculata.
——— reticulata.
Zaphrentis Enniskilleni
Archæocidaris Urii.
——— vetusta.
Palechinus elegans.
——— gigas.
Actinocrinus lævis.
——— polydactylus.
——— triacontadactylus.
Cyathocrinus planus.
Platycrinus lævis.
——— rugosus.
Poteriocrinus crassus.
——— lævis.
Serpula hexicarinata.
——— parallela.
Dithyrocaris sp.
Leperditia Okeni.
Entomoconchus Scouleri.
Griffithides globiceps.
Phillipsia Brongniarti.
——— Colei.
——— derbiensis.
——— pustulata.
Ceriopora interporosa.
——— rhombifera.
Fenestella antiqua.
——— crassa.
——— ejuncida.
——— frutex.
——— membranacea.
——— Morrisii.
——— tenuifila.
——— undulata.
——— verrucosa.
Glauconome bipinnata.
——— pluma.
Ptylopora flustriformis.
Vincularia dichotoma.
Athyris ambigua.
Aviculopecten arenosus.
———concentrico-striatus
——— dissimilis.
——— granosus.
——— hemisphericus.
——— interstitialis.
——— lævigatus.
——— plicatus.
——— priscus.
——— Sowerbyi.
——— tessellatus.
Axinus axiniformis.
——— deltoideus.
——— obliquus.
Byssoarca lanceolata.
Cardiomorpha oblonga.
Cypricardia sinuata.
Cyprina Egertoni.
Edmondia gibbosa.
——— oblonga.
——— obsoleta
——— prisca.
——— quadrata.
——— sulcata
Leda attenuata
——— clavata.
Lucina antiqua.
Mactra ovata.
Modiola Macadami.
——— patula.
Modiolopsis Brycei.
Myacites tumida.
Myalina Verneuilii.
——— gryphus.
Pinna affinis [*sic*]
——— flabelliformis.
——— flexicostata.
Pleurorhynchus aliformis.
——— fusiformis.
——— hibernicus.
——— rostratus.
Posidonomya vetusta.
Pullastra bistriata.
——— scalaris.
Sanguinolites angustatus.
——— attenuatus.
——— discors.
——— plicatus.
——— tricostatus.
Solenopsis pelagicus.

Athyris planosulcata.
——— Royssii.
Chonetes comoides.
——— hardrensis.
——— papilionacea.
——— sarcinula.
Cyrtina carbonaria.
Discina nitida.
Leptagonia plicatilis.
Orthis Michelinii.
——— resupinata.
Productus aculeatus.
——— fimbratus.
——— giganteus.
——— margaritaceus.
——— mesolobus
——— punctatus.
——— pustulosus.
——— scabriculus.
——— semireticulatus.
——— undatus.
Rhynchonella pleurodon.
——— pugnus.
Spirifera bisulcata.
——— cuspidata.
——— glabra.
——— laminosa.
——— lineata.
——— striata.
Spiriferina cristata.
Streptorhynchus crenistria.
Terebratula hastata.
Avicula lunulata.
Aviculopecten alternatus.
Euomphalus acutus.
——— carbonarius.
——— catillus.
——— crotalostomus.
——— dionysii.
——— pentangulatus.
——— pileopsideus.
——— planorbis.
——— plicatus.
——— serpuloides.
Loxonema Lefebrei
——— megaspira
Macrocheilus spiratus.
Natica elliptica.
——— plicistria.
Pleurotomaria abdita.
Bellerophon apertus.
Porcellia puzosianus.
Goniatites crenistria
——— mutabilis
Nautilus biangulatus.
——— bisulcatus.
——— tetragonus.
Orthoceras Goldfussianum.
——— inæquiseptum.
——— Steinhaueri.
Cladodus mirabilis.
Cochliodus contortus.
——— deltoideus.
Deltodus sublævis.
Helodus gibberulus.
——— lævissimus.
Palæoniscus (spine).
Psammodus porosus.
——— rugosus.

101. Mitchell, W. F., and Kilroe, J. R.—Explanatory Memoir to accompany the Maps of South-West Donegal, Sheets 22, &c. Chap. VI. Sedimentary Rocks, Carboniferous.
Mem. Geol. Surv. Ireland.

The principal mass forms the northern coast of Donegal Bay.

The *Lower Carboniferous Conglomerates, Sandstone, and Shales* lie upon or are faulted against the metamorphic rocks. They consist of dark red and purple coarse conglomerates, changing to sandy flags, grey calcareous flags and shaly limestones. All dip S.E. at 30°—40° and show a thickness of 2,000 ft. along the Oily river.

The *Lower Limestone* occurs in Muckros, where it is fossiliferous. It becomes more shaly and less important towards the north—at Killin Hill showing only a few grey earthy beds —or even disappearing.

The *Middle Limestone or "Calp."*—This is described as consisting of Sandstone, scarcely separable from the Lower

Sandstone where the two come together as at Killin, and of an underlying bed of shale which also dies out northwards, but at its best contains thin limestone bands. It is this series that yields the Mount Charles building stone.

Besides this mass, the Lower Carboniferous Sandstone is found capping Slieve League, as two outliers. This is the highest point to which the series reaches in Donegal, and indicates a much wider extension than at present. The sandstone is conglomeratic at the base.

The following fossils are determined by W. H. Bailey from these rocks, from six localities:—

Filicites linearis.
Sagenaria veltheimiana.
Chætetes tumidus.
Cyathophyllum cylindrica.
Favosites parasitica.
Lithodendron affine.
———— junceum.
Michelinia favosa.
Syringopora geniculata.
———— reticulata.
Archæocidaris Urii.
Palechinus elegans.
———— gigas.
Actinocrinus lævis.
Cyathocrinus planus.
Serpula parallela.
Phillipsia derbiensis.
———— pustulata.
Fenestella antiqua.
Athyris ambigua.
Athyris planosulcata.
———— Royssii.
Orthis Michelini.
———— resupinata.
Productus punctatus.
———— scabriculus.
———— semireticulatus.
———— undatus.
Rhynchonella pleurodon.
Spirifera laminosa.
———— striata.
Streptorhynchus crenistria.
Aviculopecten arenosus.
Pleurorhynchus fusiformis.
Euomphalus acutus.
———— pileopsideus.
———— serpuloides.
Bellerophon apertus.
Cochliodus deltoideus.
Psammodus rugosus.

***102. Fitzpatrick, J. J.—Report on the Field Meeting of the Society at a Section in the Middle Coal-measures, between Garswood and St. Helens.**

Proc. Liverpool Geol. Soc., vol. vi., p. 289.

This is called the Ravenhead section, and shows the outcrops of the "Main Delf" and other seams near Garswood. The first, near the first railway bridge seam, is 2½ ft. thick; the second, at a quarter of a mile from the station, 4 ft.; the third, at half a mile, 5 ft.; the fourth, near a bridge, 2½ ft.; the fifth, near a fault, 3 ft.; the sixth, at a mile, 5 ft.; with a stiff light brown clay above, and 4 ft. of underclay with ironstone nodules below; the 7th, at 1½ mile, 6 ft. These seams correlate with the Wigan 5 ft., 4 ft., and 9 ft. coals. The dip is generally to the south-east.

103. Hoskold, H. D.—Geological Notice upon the Forest of Dean.

Proc. Cotteswold Nat. F. Club, vol. x., p. 123, with 2 plates.

Gives a general description and discussion of the Coal Field, mostly from published sources. Notices that the Mill-

stone Grit is absent and discusses whether the patch of coal at Newent may not belong to the Millstone Grit rather than to the Coal-measures. Examples of wash-outs are met with. Sections of the strata, not stated to have been previously published, are given at Lightmoor Colliery, 890 ft.; Bowson Colliery, 806 ft.; also at Pilhowell Level Pit from the Yorkley to the Coleford High Delf, 394 ft.; at Speech House Hill, from the Starkey to the Churchway High Delf, 393 ft.; at Foxes' Bridge, from the 20 in. seam to the Churchway High Delf, 906 ft.; at Flower Mill, from the Yorkley to the Coleford High Delf, 404 ft.; at Park Hill, from the Yorkley to the Trenchard, 711 ft.; at Trafalgar, from the Crow Delf to the Churchway High Delf, 590 ft.; at Horse Engine Pit from the Smith coal to the Rockey, 223 ft.; and at the New Engine Pit from the Lowery to the Brazilly 518 ft.; also a general section at the Lower Point of the Basin as follows:—

	ft.	in.		ft.	in.
Strata	80	0	Strata	54	0
Upper Woorgreens	2	0	Brazilly	2	6
Strata	42	0	Strata	261	0
Lower Woorgreens	2	0	Yorkley	2	6
Strata, with thin coals	634	0	Strata	120	0
Crow Delf	1	6	Whittington	2	6
Strata	30	0	Strata	132	0
Smith	2	0	Coleford	4	6
Strata	18	0	Strata	126	0
Little Delf	1	2	Trenchards	2	6
Strata	24	0	Strata	144	6
Lowery Delf ..	2	8	Sandtone vein of iron ore	5	0
Strata	33	0	Strata	100	0
Starkey Delf ..	1	10	Mountain Limestone ..	70	0
Strata	39	0	Iron Ore	30	0
Rockey	2	0	Limestone..	94	0
Strata	60	0	Iron Ore	6	0
Chuchway High Delf	2	8	Mountain Limestone ..	800	0
Strata	54	0	Old Red Sandstone		
No coal	1	4			

***104. Brockbank, W., and De Rance, C. E.—Notes on the Geological Section Exposed in the Railway Cutting from Levenshulme to Fallowfield.**

Mem. Manchester Lit. and Phil. Soc., vol. iv., No. 4, part i., p. 282, and part ii., p. 339, with three folding (= 1 continuous) plates.

This cutting reveals the junction of Coal-measures with Permian, and probably shows higher beds of the former than anywhere else in England. It commences at the top with brecciated marls, the cracks filled with green sandy material. These show green spots with dark centres—called "fish-eyes"—probably of coprolitic origin, as the centre yields

carbon and phosphoric acid. The total thickness is 72 ft. They rest on flaggy limestones, with green shale partings—2 ft. in all—and surfaces showing fish scales and spines. They are pink in colour, and conchoidal in fracture, and show coprolitic patches. The *Spirorbis* here is rare; *Leia Leidyi* was found in the shale partings; and entomostraca are observed under the microscope. Next follows 9 in. of red rubbly rock, and then 30 ft. of purple and green marls. Some towards the top yield plant-remains, and towards the base red hæmatite. The second group of limestones, five in number, are thicker bedded and rougher. They are pinkish or dark, and are mottled either with bright spots which are the sections of *Spirorbis*, 5,000 to the cubic inch, or with oval green spots, which are sections of ostracods. Thickness, 6 ft. 3 in. Then follow 12 ft. 6 in. of marls with limestone, with *Spirorbis* and plant-remains. The third group of limestones has a thickness of 4 ft. 6 in. and contains three limestones and two bastard limestones, the former of pinkish grey colour, full of *Spirorbis*, and spotted with ostracods. Then comes a 3 ft. 6 in. band of hæmatite marl, and then a 2 ft. 10 in. group of limestones, which are rough and pitted with holes. The colour is dark, with yellow stains. Next comes a series, 17 ft. thick, of variegated shales and marls, which they call from their colour the "æsthetic" marls. The fifth limestone is 3 ft. 6 in. thick, pink and pitted. It is irregular in structure, and composed of *Spirorbis*, with "fish-eye" coprolites and ostracods. Next comes 16 ft. of variegated marls, full of "fish-eye" nodules. The sixth group of limestones is the most fossiliferous. It is 3 ft. 4 in. in all, the centre being 1 ft. 11 in. of purple marls. These limestones are blue, and blotched with pink where *Spirorbis* occurs. They contain *Anthracomya*, *Posidonomya*, *Megalichthys*, and *Strepsodus*, not specifically determined. This group resembles the Ardwick limestone. It is separated from the next by 10 inches of reddish marl. The seventh group is 7 ft. 6 in. in several bands, all with dark purple fracture, irregular wavy surfaces, and filled with entomostraca, tubes of *Ortona carbonaria* and *Spirorbis ambiguus*. The eighth group is the most massive, 3 ft. 10 in. in two bands, which take a fine polish; they are dark coloured, with pale pink spots, and the usual shells. The section ends downwards in red and green marls.

The three plates have a total length of 7 ft. 6 in., and between them show the whole section on a true scale of 1 in. to 8 ft. The colours are those of nature, and the dragging forward of the outcrops of the several rocks by the ice which left the overlying boulder clay is clearly shown.

Part II. gives an account of the continuation of these beds downwards.

The part already described amounts to 230 ft., of which 24 ft. is pure limestone; below come 244 ft. red, green, and purple marls, with only a 10 in. limestone band about one-quarter down. This contains patches of hæmatite mixed with entomostraca. A repetition of the whole section consecutively is then given, also other sections for comparison, as the Clayton Vale boring, Openshaw, showing 263 ft. of shales with 34 ft. of limestone, breccia, and ironstone. The fauna of these limestones is in process of being worked out.

105. Roeder, C.—Further Notes on the Upper Coal-measures at Slade Lane, Burnage.

Trans. Manchester Geol. Soc., vol. xxi., p. 129.

Four more beds are here described in addition to those enumerated before [No. **165**, 1890.] They are seen on the south side of the cutting.

In the bed which fits in with the previous section are some *Gervillias* very like the Permian *G. antiqua*.

***106. Jones, T. R.—Address to the Geological Section of the British Association, Cardiff, August, 21, 1891.**

Geol. Mag., Dec. 3, vol. viii., pp. 517 and 560.

A general summary of our present information about a variety of subjects connected with coal in general, and that of South Wales in particular, with full references to various authors. The following information about the South Wales coal-field is supplied by **W. Galloway**: "The *long-flaming* bituminous seams are about 700 yards higher in the ground than the semi-bituminous seams, the semi-bituminous, or good *steam-coal*, are 200 or 300 yards above the *dry steam-coal* seams, the last are perhaps 300 yards above the *bastard-anthracites*, and these inferior anthracites may be 400 yards or more above the *perfect anthracites*."

107. Holgate, B.—The Carboniferous Strata of Leeds and its immediate Suburbs.

Rep. Brit. Assoc. for 1890, p. 795.

Notes that much brick-making has arisen round Leeds, and the materials are taken from all parts of the Coal-measures and mixed. In this way a continuous section is exposed through 300 ft. of strata, including the outcrop of four coals.

***108. Stirrup, M.—Note on a Boulder from the Coal of Aldwarke Main Colliery, near Rotherham, Yorkshire.**

Trans. Manchester Geol. Soc., vol. xxi., p. 170.

The Boulder is of dark grey quartzite, it is oval and water-worn, and weighs 5½ lbs. It is coated with a carbonaceous pellicle, and occurs in the lower or "Bottom softs" portion of the Parkgate Seam of the Middle coals.

***109. Stirrup, M.—Granite Pebble from the Sand-Rock Mine, Bacup, Lancashire.**

Trans. Manchester Geol. Soc., vol. xxi., p. 172.

It is $3\frac{3}{4}$ by $2\frac{3}{4}$ inches, and weighed when whole $1\frac{1}{4}$—$1\frac{1}{2}$ lbs. It occurred in a thin coal seam in the Rough Rock. It has been examined by T. G. Bonney, who says it is a true granite, with both felspars and biotite.

110. Woodward, H. A.—Notes on the Finding of Natural Grease in the Cannel Mine at the Newtown Collieries of the Clifton and Keisley Coal Company, Limited.

Trans. Manchester Geol. Soc., vol. xxi., p. 175.

In a fault in the Cannel was found about 56 lbs. of grease, which on analysis yielded: Fatty matter 71·13, water 6·17, insoluble 22·70. Gas issued from the continuation of the fault below. The grease is supposed to be produced by the distillation of the organic matter in the Cannel under the influence of some local heat.

PERMIAN.

111. Tiddeman, R. H.—The Geology of the Country around Mallerstang, &c.

Mem. Geol. Survey, chap. xii.

In the map here dealt with (97 N.W.) only the southern end of the Permian rocks of the Vale of Eden are met with. They consist of "Brockram," a breccia of limestone fragments cemented by red calcareous cement, reaching a thickness of 200 ft. This lies unconformably in the hollows of the Carboniferous Limestone from which it is derived, and as which it becomes as hard.

Near Kirkby Stephen is an outlier of Red Sandstone which is taken by Mr. Aveline to represent the St. Bees Sandstone on account of its fineness of grain, and thereby to prove an overlap, but by the author to be a finer variety of the Penrith Sandstone forming part of the Brockram group.

***112. Howse, R.—Note on the Conglobated Form of the Magnesian Limestone of the County of Durham.**

Nat. Hist. Trans. North., Durh., and Newcastle-on-Tyne, vol. xi., p. 60.

The concretionary structure is superinduced, because there are often lines of shells passing through the concretions and intervening marls alike. The carbonate of line now crystallised has, he considers, been introduced from above by water

dripping from the overlying bed, only differing from stalactitic formation in the presence of the marl.[1]

113. Garwood, E. J.—On the Origin and Mode of Formation of the Concretions in the Magnesian Limestone of Durham.

Geol. Mag., Dec. 3, vol. viii., p. 433, pls. xii., xiii.

The object of this paper is to disprove the "Stalactitic Theory" of the origin of these concretions [see No. **112**]. The arguments are summed up as follows. The stratification is not obliterated as it should have been, but passes through matrix and concretion alike. They are too thick to have been formed in this way. They characterise the Upper Limestones, which are overlaid by only slightly calcareous, and not eviscerated Trias. They are not found in ordinary limestones. They contain shells, which are absent from the matrix, and often central cavities. The proportion of magnesia to lime in the concretionary beds as a whole is similar to that in the non-concretionary. The amount of magnesia in contiguous concretions varies, and they contain some insoluble matter; and finally stalagmitic calcite sometimes clothes the concretions and is of a different character. He suggests that the concretions have been formed by the carbonate of lime crystallising about organic nuclei after the manner of flints, too little magnesia making them too small to be noticed, and too much preventing the coming together of the lime carbonate. The Plates show four concretions and a photographic view of the stratification in Marsden Quarries.[2]

114. Jukes-Browne, A. J.—Concretions in Magnesian Limestone.

Geol. Mag., Dec. 3, vol. viii., p. 528.

Believes that the calcareous matter was precipitated during and not subsequently to the formation of the bed.

***115. Morton, G. H.—The Geology of the Country around Liverpool. 2nd Edition. [See No. 91.]**

The only exposures of Permian rocks are at Skillaw Clough, where are 6 ft. of magnesian limestone and 65 ft. of sandstones and shales; at Bedford, near Leigh, where the limestone was quarried, and at St. Helen's Junction, where 40 ft. of marls and sandstones are seen. In other places the Permian is merely assumed from its being sandstone or red

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[1] If this were their origin they should be conical in form with the apices lowest, but instead of this they are spherical.

[2] As these concretions are quite exceptional products, no method of accounting for them can be the right one, if it is equally applicable to all magnesian limestones. There must be some *special* cause, possibly a tufaceous origin, as suggested by A. H. Green [No. **188**, 1890].

marl above the Coal-measures, and it is not certain whether it is distinct from the Lower Red Sandstone of the Trias. Various sections given show thicknesses of 118 ft., 66 ft., 16 ft. 6 in., 13 ft., 111 ft., 141 ft., 526 ft., 276 ft.[1]

TRIAS.

***116. Morton, G. H.—The Geology of the Country around Liverpool. 2nd Edition.** [See No. **91.**]

The thickness of the Trias is estimated as follows, Keuper Marl 400 ft.,[2] Keuper Sandstone 400 ft., Upper Soft Sandstone 550 ft., Upper Pebble Beds 400 ft., Lower Pebble Beds 600 ft., Lower Soft Sandstone 400 ft.

The Lower Soft Sandstone is well seen at Eccleston Hall, ½ mile along the cutting south of Rainford Station, at Eastham and Burton Point south of Neston, also at New Pale, south of Huyton, where the horizon is rather doubtful. It is often characterised by containing large grains ("millet seed") amongst smaller.

The Pebble Beds are divided into two groups, because the upper part contains few or no pebbles. The lower is divided into beds 6—10 ft. thick by seams of shale, and the pebbles are remarkably uniform in size and distribution, seldom above 1—2 in. in diameter, and consisting almost entirely of dark red quartzite, vein quartz, black chert and grey grit. Some details are given of the exposures at Olive Mount, Prescot, where the pebbles indent each other; Melling; Woolton, with good building stone; Rainhill; Speke Station; Wirral; Burton Point, where is a conglomerate of 12 ft. at the base, with very large pebbles of white quartz; Hilbre Island, where there is a remarkable conglomerate of coarse grit and marl, looking like Carboniferous, with angular pieces of quartz and quartzite. Another similar conglomerate occurs at the extreme north-west of Wirral at Redstones and Hilbre point; a section of 79 ft. at the latter is given, showing three bands of breccia-conglomerate, the pebbles of which are very large, and some are Carboniferous and Silurian. Here occurs a band of shale with annelid tracks,[3] and above it a band which has been cracked in the sun,

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[1] It is very improbable that each of these can represent the real thickness of the Permian.

[2] W. Boyd Dawkins, reviewing this work in "Nature," says the Keuper Marls in the Cheshire Plain are 700 ft. thick and the Lower Bunter 1,300 ft.

[3] The only sign of life in the Bunter.

letting in the overlying sand into the cracks, and on another surface are ripple marks.[1]

The Upper Pebble Beds are well seen at Edge Hill, Everton, and Bootle; it is often used for building. Only one pebble has he ever found in these beds.

The Upper Soft Sandstone is seen in the railway cuttings at Dingle Point and beyond New Brighton. The upper part is often yellow, 120 ft. of such rock being pierced at Flaybrick, above the red sandstone. It is of no use for building.

The Keuper Sandstone has a hard conglomerate at the base, with pebbles of quartz and marl. There are also bands of marl in the middle. Sections are given at Toxteth Park, and along three directions in Liverpool, showing the faults and succession. At Storeton, of the quarries at which a section is given, the Keuper Sandstone is let down into the soft Bunter Sandstone by some trough faults. The section here is: White stone 36 ft., footprint bed 3 ft., white stone 33 ft., marl bed 2 ft., white stone 30 ft., shale and marl 14 ft., basement beds 45 ft. The "white stone" is the building stone for which the quarry is worked. The footprints were made on the marls and modelled by the overlying sandstone bands. Plates viii. to xii. give old and new illustrations of the *Cheirotherium* and *Rhynchosaurus* footprints, and of *Equisetites keuperina*. At Oxton the total is 53 ft. with 20 ft. of the basement beds, and on Bidston Hill, 40 ft. of basement beds are seen. These are current-bedded sandstones, with nodular bands of marl, the pebbles occurring in zones. In Wallasey there are numerous exposures, none indicating more than 50 ft., but a new boring has been made at Liscard, showing (under 23 ft. 3 in. of Boulder Clay) 170 ft. of Keuper Sandstone, in 14 subdivisions, mostly yellow sandstones, with occasional pebbles but no conglomerate, only a hard sandstone bed at the base, below which was 44 ft. 6 in. of yellow and 360 ft. of red soft Bunter Sandstone. Other exposures are described at West Kirby on Grange Hill; at Thurstaston where the coarse grit base is preceded by the Bunter Sandstone; at "Thorstone," a projecting mass of rock; at Heswell, Irby, and Frankby.

The Keuper Marls are only locally left undenuded, they yield pseudomorphs of salt; but there are no Waterstones except in Wirral, as at Upton and Greasby. The thickness assigned is only the minimum.

The microscopic character of the sandstones he has previously described; some are cemented by secondary quartz. Amongst the pebbles of the Bunter are felspathic grits, and

[1] These are very interesting observations, as showing the conditions of deposit at this spot at least.

others resembling beds in the Cefn-y-Fedw Sandstone, also halleflinta and decomposed quartz felsites, sandstone like Upper Silurian, and pink granite. The Keuper pebbles include halleflinta, decomposed rhyolite, and quartz felsite, but none of the liver-coloured quartzites. On these pebbles there is a note by **T. G. Bonney** to the effect that they are "derived from the same sources as those in the Staffordshire district, only they are smaller, and perhaps not quite so well rounded." A summary of other opinions is also given, and the author, owing to the absence of marine remains, inclines to the fluviatile theory. He doubts whether there are really more pebbles in Staffordshire, only less intervening sand. Two general sections are given in Plates xiv. and xv., east and west, across the whole district and across Liverpool.

***117. Morton, G. H.—Notes on the Bunter and Keuper Formation in the Country around Liverpool.**

Rep. Brit. Assoc. for 1890, p. 819.

The information in this paper is included in No. **116.**

118. Beasley, H. C.—The Base of Keuper in the Northern Part of Wirral.

Proc. Liv. Geol. Soc., vol. vi., p. 248.

This base is seen at Flaybrick Hill. It there consists of 2—6 in. of grey current-bedded shale, mixed with a pinkish conglomerate, which follows the irregularities of the Bunter; above this is 10 ft. (+ 75 ft. removed) of pebbly sandstone. Elsewhere, in the same quarry, there are 8—10 ft. of Keuper conglomerate. In the Tollemache Road there are 10 ft. of irregular-bedded sandstone, and below, 13 in. of quartz-conglomerate in cavities of the Bunter. At the footbridge at Bidston Hill, there is thin-bedded sandstone without pebbles 4 ft., and conglomerate 10 ft., lying on Bunter Sandstone—the lower part of the conglomerate mixing with the Bunter. At Poulton, the bedded marly sandstone lies on the Bunter, with only occasionally patches of conglomerate. At Wallasey, 10—12 ft. of Keuper Sandstone are seen, containing very few pebbles, and with no sign of conglomerate, except near the top. The upper surface of the Bunter is uneven. This upper conglomerate is very coarse not far away in a quarry. At West Kirby, a thin bed of shale separates the Keuper from the Bunter. These sections indicate that there was erosion of the Bunter before the Keuper was deposited, but that the former was still soft.

***119. Reade, T. M.—The Trias of the Vale of Clwyd.**

Proc. Liverpool Geol. Soc., vol. vi., p. 278.

The exposures noticed at various spots within the Vale are recorded.

They are all very nearly alike, being false-bedded soft red sandstones. This may represent nearly the whole of the Bunter in an area where there was no conglomerate. As the Vale is due to pre-Triassic denudation, it formed an inlet in the Trias sea, though since let down by a fault. The most striking feature is that the Trias sandstone is almost absolutely independent of the surrounding rocks, *i.e.*, it contains almost no local *débris*. He concludes that there must have been a considerable depth of water over the spot, so that the shore lines were far away.[1]

***120. Hind, W.—The Geology of Whitmore.**

Ann. Rep. and Trans. N. Staffordshire Nat. F. C. for 1891, p. 40.

The Pebble beds here contain comparatively few pebbles. An account is given of the differences of opinion as to the origin of the Bunter, and the author thinks the thickness in Cheshire, and the coarseness in the Midland counties, is a difficulty in either case. Some of the quartzite pebbles may have come from the Lickey.

***121. Lapworth, C.—The Geology of the Dudley District.**

"Midland Naturalist," vol. xiv., p. 269.

Compares the Coal and Trias to a black blanket and a red blanket, the black blanket only showing where time and weather had worn holes in the red blanket above. "Geologists believed that the Trias was laid down in a desert like the Sahara, or in a saline plain like that round the Caspian Sea." The Permian has now been found to lie unconformably on the Coal-measures in the north of the coal-field, so that there may be coal between Walsall, Tamworth and Ashby. The Breccias of Clent and Stourbridge, considered by Ramsay to have been of glacial origin, have been "all but proved" to be local subaerial *débris*.

***122. Stock, T.—Observations on a Keuper Conglomerate, and on a Breccia, both recently exposed in the Neighbourhood of Bristol.**

Geol. Mag., Dec. 3, vol. viii., p. 213.

Notes a 6 in. bed of conglomerate chiefly of small quartz-pebbles found in the Keuper in Argyle Street, also some beds at Greenhill, Alveston, which are horizontal and "homogeneous" at the base, but become a breccia of Carboniferous Limestone fragments at the top. The age is not determined.

***123. Worth, R. N.—Additional Notes on the Cornish Trias.**

Trans. Roy. Geol. Soc. Cornwall, vol. xi., p. 338.

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[1] Not far enough to prevent it being an inlet.

In addition to the Triassic blocks dredged up in the Channel off Cornwall as recorded in Quart. Journ. Geol. Soc., vol. xlii., a slab of Triassic conglomerate has now been broken off a submarine reef 7 miles south of Deadman. This is thought to belong to an independent smaller outlier, being of a different character from the rest.

It is also noted that in the nearest Trias exposure at Whitsand Bay, near Cawsand, there is a dyke which, within four or five yards, and therefore under practically the same conditions of cooling, passes from a rhyolitic pitchstone to a trachytic quartz felsite. The Cawsand Bay rock has been called an andesite, but he proposes "to regard our varied granites and andesites as rather pathological conditions of a common original."[1]

RHÆTIC AND LIAS.

*124. Wilson, E.— On a Section of the Rhætic Rocks at Pylle Hill (Totterdown), Bristol.

Quart. Journ. Geol. Soc., vol. xlvii., p. 545.

This section is in a new cutting on the Bristol Reliet Railway. It shows at the top 4 ft. 5 in. of limestones and shales with *Am. planorbis* and *Am. torus*, *Lima gigantea*, *Pholadomya glabra*, &c., followed by 4 ft. 9 in. of fine limestone bands with *Ostrea liassica*, *Lima gigantea ?*, *Modiola minima* and *Monotis decussata*, all of which he refers to the Lower Lias. The series below commences with a 3 in. band of concretionary limestone which is correlated with the Cotham Marble, which he takes to be the top of the Rhætic. This with four alternations of light blue limestones and shales, amounting in all to 7 ft. 7 in., and containing *Saurichthys acuminatus*, *Gyrolepis Alberti*, *Acrodus minimus*, *Pecten valoniensis*, *Plicatula intusstriata*, *Cardium rhæticum*, *Schizodus Ewaldi*, *Estheria minuta*, and *Naiadita*, he classes as "Upper Rhætic Series," in place of the name "White Lias." The eight beds of black shale and one limestone below amount to 9 ft. 5 in., and contain :—

Ceratodus.	Schizodus Ewaldi.
Hybodus cloacinus.	——— concentricus.
——— minor.	Myophoria Emmrichi.
Acrodus minimus.	Gervillia precursor.
Saurichthys acuminatus.	Modiola minima.
Gyrodus Alberti.	Cardium rhæticum.
Natica Oppeli.	Pecten valoniensis.
Acteonina oviformis.	Avicula contorta.

[1] It appears that this is meant for an answer to some difficulty about his theory of Dartmoor granite being the base of a volcano to which the traps belong.

Anatina Suessi.	Plicatula Archiaci.
Pleurophorus granulatus.	Ostrea alpina.
Lucina Stoppaniana.	Serpula constrictor.
Myacites striato-granulata.	Ophiolepis Damesii.

These he classes as *Avicula contorta* Shales. The underlying 9 ft. of "Tea Green Marls" with plant-remains are more intimately connected with 40 ft. of Red Keuper Marls below than with the beds above, and he accordingly classes them as Keuper.

***125. Walker, J. F.—On Liassic Sections near Bridport, Dorsetshire.**

Rep. Brit. Assoc. for 1890, p. 799.

Gives four sections at different spots. Two are in N. Allington showing beds above the marlstone, in the second are white and pink stone with *Am. striatulus* and *Rh. Bouchardi* respectively, 14 in., followed below by Marlstone 6 in., with *Rh. tetrahedra*. A third is at Symondsbury, and a fourth at Bothenhampton, where the marlstone is covered by a pink sandy conglomerate; the former with *Am. spinatus*, *Rh. serrata*, and *Rh. tetrahedra*, the latter with *A. bifrons*, *R. Bouchardi*, and worn specimens of *A. serpentinus* and *A. crassus*, and immediately above is a brown rock with *A. striatulus*, and then a white rock with *A. aalensis* and *A. germanii*; all this in 5 ft. 6 in. The conglomerate contains the fossils of the missing zones redeposited.

126. Clarke, J. F. M.—The Geology of the Bridgwater Railway.

Proc. Bath N. H. and Ant. F. C., vol. vii., p. 127, with a plate.

The cuttings of this railway pass through the northern slopes of the Polden Hills. Going from south to north, the first cutting is in the Red Marls, above which in a quarry are seen the Lower Lias beds with *Pleuromya crowcombeia*. Further on is a synclinal showing 180 ft. of the Bucklandi and Planorbis zones, the former mostly clay. Near the Bridge under Woolavington Lane comes an anticlinal with black Rhætic shales in the centre, 12 ft. thick with layers of "beef," *Cardium rhæticum*, *Pecten valoniensis* and *Avicula contorta*. Beyond Cossington Dingle the strata are much disturbed, but consist of beds with *P. crowcombeia* and *Plesiosaurus*. Further to the east is a bed crammed full of *Am. planorbis* of an iridescent appearance, and a leaf of *Otozamites* and vertebræ of *Ichthyosaurus*. *Rhynchonella variabilis* is also met with in great abundance.

***127. Smithe, F., and Lucy, W. C.—Some Remarks on the Geology of Alderton, Gretton, and Ashton-under-Hill.**

Proc. Cotteswold Nat. F. C., vol. x., p. 202, with a plate.

This is a record of a visit paid by the Club to these localities in 1879. They show part of the Spinatus-zone and the first two show the Upper Lias. The section at Alderton is:

	ft.	in.
Buff and Grey Clays (conchoidal)	6	0
Paper Shales of Communis beds		
Fish bed	25	0
Communis and Bifrons zone		
Bituminous laminated shales		
Fine light Grey, non-laminated clay with *Leptæna*	4	6
Rock bed to base	4	6

The following fossils are recorded as from the stacks:—

UPPER LIAS—

Stephanoceras commune.
Harpoceras serpentinum.
———— annulatum.
———— bifrons.
———— lythense.
———— radians.
Belemnites cylindricus.
———— paxillosus.
Terebratula globulina
———— pygmæa.
Euomphalus minutus.
Inoceramus dubius.
Plicatula spinosa.
Harpax calvus.
Lima toarcensis.[1]
Limea acuticosta.[1]
Cardinia lævis.
Leda ovum.
—— galathea.[1]
—— minor.[1]
—— subovalis.
Monotis substriatus.

MIDDLE LIAS—

Extracrinus subangularis.
Amaltheus spinatus.
Phylloceras zetes.
Harpoceras aalense.[1]
Amaltheus margaritatus.
———— Engelhardti.
Belemnites paxillosus.
———— breviformis.
Pleurotomaria amalthei.
Pitonillus sordidus.
Turbo cyclostoma.
Terebratula punctata.
———— Edwardsi.
Waldheimia Mariæ
———— cornuta.
Rhynchonella acuta.
———— tetrahedra.
Ostrea cymbium.
——— submargaritacea.
Avicula inæquivalvis.
Modiola subcancellata.
——— scalprum.
Pecten æquivalvis.
Pecten priscus.
——— substriatus.
——— lunaris.
——— acuticostatus.
Unicardium globosum.
Lima gigantea.[1]
Hinnites tumidus.
Myoconcha decorata.
Modiola numismalis.
Gresslya ovata.
——— intermedia.
——— Seebachii.
——— donaciformis.[1]
——— striata.
Pleuromya costata.
Arcomya arcacea
Pinna Hartmanni.
Pholadomya ambigua.
Gervillia ærosa.
Protocardium truncatum.
Ceromya bombax.
——— petricosa.

128. Hawkesworth, E.—From Kettleness to Saltburn.

Trans. Leeds Geol. Assoc., part vi., p. 55.

[1] These records are unusual, and perhaps doubtful.

A very brief account of the Lias cliffs in this neighbourhood.

THE OOLITES.

***129. Newton, E. T.—Note on the Occurrence of *Ammonites jurensis* in the Ironstone of the Northampton Sands, in the Neighbourhood of Northampton.**

Geol. Mag., Dec. 3, vol. viii., p. 493, and Journ. North. Nat. Hist. Soc., vol. vi., p. 266.

Some ammonites from the Ironstone at Duston and Brixworth have been examined, and certain of them are referred to *Am. jurensis*, and others in the same bed to *Am. opalinus*, &c. His conclusion is that, at present, "ammonite zones are not so sharply defined in this area as they are considered to be in some localities."[1]

***130. Buckman, S. S.—The Ammonite Zones of Dorset and Somerset.**

Geol. Mag., Dec. 3, vol. viii., p. 502. Abstract of paper read at the Brit. Assoc., Aug., 1891.

Commencing at the base of the Inferior Oolite, we have the *Opalinum*, and then the *Murchisonæ* zone intimately connected with it; above these there is often a break. In the Bradford Abbas district the *Concavum* zone may be recognised; it is the absence of this on the continent that has accentuated the break, and caused the line between Toarcian and Bajocian to be drawn here. When present the *Concavum* zone must be joined to the former. The *Sowerbyi* zone is only known at Dundry and at Coombe quarry, near Sherborne, the latter being now closed; the absence of the zone elsewhere makes the break. The *Sauzei* zone above may be recognised at Frogden, near Sherborne. Next comes the *Humphresianum* zone, and at Frogden a higher horizon may be separated as the *Cadomensis* zone. Some continental authors, who unite this latter with the *Parkinsoni* zone above, make it commence the Bathonian, and with this he is inclined to agree. The *Parkinsoni* zone, however, he splits up into the *Truellei*, *Zigzag*, and *Fusca* zones.

***131. Wethered, E.—The Inferior Oolite of the Cotteswold Hills, with Special Reference to its Microscopical Structure.**

Quart. Journ. Geol Soc., vol. xlvii., p. 550, pt. xx.

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[1] There are more than one species of Inferior Oolite ammonite which closely resembles *A. jurensis*, and the specimen figured by Wright, with which the present one is said to "exactly agree," is one of them. This is probably therefore not the true liassic *A. jurensis*, which may some day be found in some of the clays *below* the ironstone.

The Inferior Oolite is classed in ascending order, as—

I. *The Transition Beds.*—Of these he gives the following section in the third cutting of the Andoversford Railway: Argillaceous 10 ft., Irregular, with *R. cynocephala*, 12 ft., Calcareous 10 in., Cephalopoda bed 1 ft. 2 in., Crystalline Limestone 6 in., Midford Sands 3 ft. 6 in.[1]

II. *The Pea-grit Series.*—Some of the "oolitic" rocks along the cutting contain organic fragments coated with *Girvanella pisolitica*, and there is a 20 in. sponge bed containing *Lymnorea mamillosa*, *L. ramosa*, and *Peronella tenuis*. Some of the beds at Horsepools contain *Girvanella*. The typical "Pea Grit" is not seen in the 11 ft. here explored; and at Horns Valley Quarry, near Stroud, 31 ft. 10 in. are described as belonging to the "Pea Grit" series, of which only 3 ft. are "typical"; but the rest show pisolitic structure, *i.e.*, *Girvanella*. He then gives a 52 ft. section of the series at Cleeve Hill in 26 subdivisions, only 8 ft. of which is typical Pea Grit. Details are given of the presence of *Girvanella* up to No. 19. In the overlying 19 ft. the oolite granules contain only traces of *Girvanella*.

III. *The Building Freestones* are well known. He has now found that the granules in the yellow part of the Upper Freestone of Chedworth also "are of organic origin."

IV. *The Ragstones.*—In these also he has found *Girvanella* at Chadworth Wood.

Of these groups, he has examined the residues from boiling hydrochloric acid. The Transition beds showed proportions from 11·1 per cent. to 88 per cent. which contained felspar, quartz, zircon, and occasionally zircon and tourmaline. The beds examined from the Pea Grit series yield from 0·2 to 8 per cent. of residue, which consists mostly of quartz grains, with occasional felspar, zircon, and rutile. In bed No. 5, at Cleeve Hill, are some quartz crystals of secondary growth, and in the typical Pea Grit at Stroud, and the Upper one at Cleeve, are siliceous casts of organic origin. The Lower Freestone yields from 0·8 to 3·2 per cent., mostly of quartz. The Oolite Marl yields 3·5 per cent. residue, and shows minute "clay slate needles," supposed to be rutile. The Upper Freestone contains only 0·8 per cent. residue when yellow, but the blue may contain 7·5 per cent. of pyrites. The overlying marl yielded clay whose analysis is—

Ignition	9·66
Silica	67·90
Alumina	18·00
Magnesia..	0·06
Loss	4·38
	100·00

[1] This is the same cutting as that described by S. S. Buckman (*see* No. **230**, 1890), but the two descriptions differ considerably.

It also yields clay-slate needles. He thinks the silica of the casts must have come from decomposed silicates. The clay-slate needles may have "been derived as detrital material from other rocks, possibly in part as inclusions in other minerals."[1] "The size of the quartz grains in the Transition beds averages 13 mm. There is a slight increase in the Pea Grit series, and a decrease in the Lower Freestone. The quartz grains in the Oolite Marl are very small; in the Upper Freestone they are nearly as large as those in the Lower Freestone, and in the Ragstones we get the largest size of any." The Plate gives six microscopic sections.

132. Harker, Allen.—On the Geology of Cirencester Town, and a Recent Discovery of the Oxford Clay in a deep Well-boring at the Waterworks.

Proc. Cotteswold Nat. Field Club, vol. x., p. 178.

The higher grounds around the town are capped by Forest marble lying on Great Oolite of considerable thickness, and in the wells here sunk the Fullers' earth is met with at less than 120 ft. down.

It is concluded that the Great Oolite is about 100 ft. thick. If the beds were continuous across the valley, the lowest part of the town would be occupied by the white beds of the Great Oolite.

Now below the town there must be a large mass of clay to serve as a base for the abundant water. A section on the Midland and South Western Junction Railway shows 18 ft. of Forest Marble Clay below 8 ft. of Cornbrash, but this is not enough. Recently, however, he has examined the materials obtained from a boring at Lewis Lane, and between 30 and 45 ft. down the following fossils were met with:—

Avicula inæquivalvis.	Belemnites Owenii.
Ostrea (young).	Modiola bipartita.
Myacites recurva.	Waldheimia ornithocephala.
Ammonites macrocephalus.	Terebratula intermedia.

These he regards as proving that the base of the valley is in Oxford Clay, which must be let down in a trough by two faults. A detailed section is given of 177 ft. 6 in. in 47 subdivisions of various limestones, with here and there some clay. Of this 22 ft. 10 in. are assigned to Oxford Clay, then 15 ft. are apparently thought to be Callovian, and perhaps Cornbrash, but the latter is not identified, and all the

[1] The above analysis does not show the titanium which must be present if the clay slate needles are rutile. These needles, in the Coal-measure Clays, are thought to be formed *in situ*, *see* No. **469**.

rest may be Forest Marble and Great Oolite, though the fossils are not yet worked out.[1]

***133. Cameron, A. C.—On the Continuity of the Kellaways Beds over Extensive Areas near Bedford, and on the Extension of the Fullers' Earth Works, at Woburn.**

Geol. Mag., Dec. 3, vol. viii., p. 504. Abstract of paper read at the Brit. Assoc. in Aug., 1891.

Concretionary sandstones belonging to the Kellaways stand out in clusters in the valley of the Ouse at Bedford like gigantic fungi; these are capped by a shelly calcareous band. Pits are opened at these beds, down to the Great Oolite Limestone, and the loamy portion, or "lam earth," is mixed with the Oxford Clay for bricks. No details are given in the abstract upon the second head.

***134. Woodward, H. B.—The Geology of Parts of Cambridgeshire and Suffolk.**

Mem. Geol. Surv., chap. ii.

Very little new evidence of Oxford Clay has been obtained since the publication of the Memoir on the Geology of Cambridgeshire in 1880–81. The Corallian rocks of Upware have yielded no new information, except additions to fossils. From the various estimates of the dip, the author concludes that no trustworthy dip is seen.

A complete list of the fossils here obtained—drawn up by **T. Roberts** for the Sedgwick Essay, is given: N = Northern (Coralline Limestone) Pit; S = Southern (Coral Rag) Pit.

Ammonites Achilles, S.	Lucina moreana, S.
——— mutabilis, S.	Modiola bipartita, N.
——— perarmatus, N.	——— *cf.* rauraciensis, S.
——— plicatilis, N., S.	——— subæquiplicata, S.
——— cawtonensis, S.	Lithodomus inclusus, S.
Belemnites abbreviatus, S.	Myacites decussata, S.
Cerithium muricatum, S.	——— recurva, S.
Chemnitzia heddingtonensis, S.	Myoconcha texta, S.
Emarginula Goldfussi, S.	Mytilus ungulatus, N., S.
Fissurella corallensis, S.	Opis corallina, S.
Littorina Meriani, S.	—— lunulata, S.
——— muricata, S., N.	—— Phillipsii, N.S.
Natica clymenia, S.	—— virdunensis, S.
——— clytia, S.	—— *cf.* paradoxa, S.
Neritopsis decussata, S.	Ostrea gregaria, S.
——— Guerrei, S.	——— solitaria, S.
Pleurotomaria reticulata, S.	Pecten articulatus, S.

[1] Not one of the above fossils is so unmistakable that nothing like it could be found out of Oxfordian Strata, and the non-recognition of the Cornbrash, which must be more than 8 ft. thick in the section, and th, small thickness of the clay, point to the possibility of these fossile belonging to the Forest Marble, witb which assignment the Brachiopodas which are the least mistakable, better agree.

Pseudomelania striata, S.
Trochotoma tornata, S.
Trubo princeps, S.
Anomia suprajurensis, S.
Arca æmula, S.
—— contracta, S.
—— pectinata, S.
—— quadrisulcata, S.
Astarte aytonensis, S.
——— ovata, S.
Cardita ovalis, S.
Cardium delibatum, S.
Cypricardia glabra, S.
Exoygra nana, S.
Gastrochæna moreana, S.
Gervillia angustata, S.
———— aviculoides, N. S. ?.
Goniomya v-scripta, S.
Hinnites velatus, S.
———— *cf.* corallina, S.
Homomya tremula, S.
Isoarca multistriata, S.
——— texta, S.
Lima elliptica, S.
—— rigida, S.
—— rudis, S.
Lucina globosa, S.
Pecten fibrosus, N., S.
——— vimineus, S.
Perna subplana, S.
Pholadomya decemcostata, S.
Plicatula fistulosa, S.
Quenstedtia lævigata, S.
Trigonia Meriani, S.
Terebratula maltonensis, S.
Gastrosacus Wetzleri, S.
Prosopon rostratum, S.
Apiocrinus polycyphus, S.
Cidaris florigemma, S.
——— Smithii, S.
Collyrites bicordatus, N., S.
Echinobrissus scutatus, N., S.
Hemicidaris intermedia, S.
Holectypus depressus, N., S.
Hyboclypus gibberulus, N.
Pseudodiadema versipora, N.
Pygaster umbrella, N.S.
Stomechinus gyratus, S.
Isastræa explanata, S.
Rhabdophyllia Phillipsii, S.
Montlivaltia dispar, S.
Stylina tubulifera, S.
Thamnastræa arachnoides, S.
————— concinna, S.

With regard to the Kimmeridge Clay, the supposed exposure at Balsars Hill is discussed, the principal evidence being the presence of a characteristic form of *Ostrea deltoidea*. A measured section of Roslyn Hole, Ely, by **Mr. Skertchly**, is given.

The following list of Kimmeridge Clay fossils in Cambrigeshire is given :—[1]

Cimoliosaurus trochanterius.
Geosaurus maximus.
Gigantosaurus megalonyx (MS.).
Ichthyosaurus chalarodeirus (MS.).
————— hygrodeirus (MS.).
————— trigonus.
Metriorhynchus ?
Peloneustes æqualis.
Pliosaurus brachydeirus.
———— brachyspondylus.
———— macromerus.
———— nitidus.
Steneosaurus.
Thallassemys Hughii.
Asteracanthus ornatissimus.
Ditaxiodus impar.
Eurycormus grandis.
Astarte supracorallina.
Avicula ædilignensis.
——— costata.
——— echinata.
——— inæquivalvis.
Cardium striatulum.
Cucullæa contracta.
Exogyra nana.
——— virgula.
Lucina minuscula.
Ostrea deltoidea.
——— gregaria.
Pecten Grenieri.
——— lens.
Trigonia clavellata.
——— Pellati.
Discina latissima.

[1] This list is compiled from several authors, so that the names rest on their authority, and there may be some duplicate entries under different names.

Gyrodus umbilicatus?
Hybodus acutus.
——— Fisheri.
Macropoma substriolatum.
Ammonites alternans.
——— biplex.
——— calisto.
——— excavatus.
——— eudoxus.
——— longispinus.
——— mutabilis.
Aptychus latus.
Belemnites abbreviatus.
——— explanatus.
Dentalium Quenstedti.
Arca minuscula.
—— rhomboidalis.
Astarte ovata.
Lingula ovalis.
Rhynchonella inconstans.
Pollicipes Hausmanni.
Cytheridea Ruperti (MS.).
——— triangulata (MS.).
Cythere æqualis (MS.).
Serpula tetragona.
——— variabilis.
Vermilia sulcata.
Vermicularia contorta
Rhabdocidaris maxima.
Cristellaria lævigata.
Marginularia gracilis.
——— lata.
Planularia strigillata.
Vaginulina harpa.
——— striata.

***135. Brodie, P. B.—Lower Greensand and Purbecks in the Vale of Wardour, Wilts.**

Geol. Mag., Dec. 3, vol. viii., p. 455.

The quarry whence he obtained insects and isopods is now filled up, and no more insect limestones have been discovered, but a beetle's elytron and an *Archæoniscus* have been obtained from the base of the Purbecks at Chicksgrove.

136. Goodman, C. H.—Notes on the Geology of the Isle of Purbeck.

Proc. and Trans. Croydon Micr. and N. H. Club, p. 276.

A very brief general outline.

***137. Lamplugh, G. W.—On the Speeton Clays and their Equivalents in Lincolnshire.**

Rep. Brit. Assoc. for 1890, p. 808.

The author has compared the succession at Speeton with that at Acre House, Lincolnshire, whence he has collected fossils, and makes the following correlations:—

Speeton.	Acre House.
Red Chalk.	Red Chalk.
A. Marls with *B. minimus*.	Carstone.
B. Zone of *B. semicanaliculatus?*	Tealby Limestone.
C. Zone of *B. jaculum*.	Tealby Clay.
D. Zone of *B. lateralis* with	Claxby Ironstone.
E. Coprolite bed.	Spilsby Sandstone.
F. Bituminous shales (Upper Kimmeridge).	Upper Kimmeridge Shales.

The topmost beds of F. may be absent in Lincolnshire owing to the overlap of the Spilsby Sandstone. The *B. lateralis* beds at Speeton contain fossils "supposed to be Portlandian," and others "usually referred to the Neocomian." The Claxby Ironstone and Spilsby Sandstone are united palæontologically.

The Tealby Clay may represent only the upper part of the *B. jaculum* zone.[1]

CRETACEOUS.

***138. Whitaker, W., and Jukes-Browne, A. J. —The Geology of Parts of Cambridgeshire and Suffolk. (Sheet 51 N.E. and 51 N.W.)**
Mem. Geol. Survey, chaps. iii. and iv.

The Lower Greensand is now very little exposed in the district. It forms a long spur by Streatham to Aldreth, and phosphatic nodules occur here, with sand and sandstone. The principal exposure has been the coprolite workings at Upware, the description of which is taken from the writings of J. F. Walker, T. G. Bonney, J. J. H. Teall, H. Keeping, and W. Keeping. There is also an outlier near Ely. The total thickness seen never seems to be more than 8 ft. The list of fossils is from the work of W. Keeping.

The Gault is only exposed over small areas, the best exposure being at a brickyard 1 mile west of Wickin Church, where 50 ft. have been penetrated in a well. The only fossil anywhere recorded is *Belemnites minimus*.

On the Lower Chalk reference is made throughout to the Cambridge district, of which the present is a continuation. The lowest portion is now called the zone of *A. varians*, the range of that species having proved to be more limited than was formerly supposed.

The Chalk Marl contains 12·20 per cent. of insoluble matter in the form of clay and a little sand, the calcareous portion being partly of impalpable mud and partly of shell fragments. The zone of *Holaster subglobosus* commences with the Totternhoe Stone, whose apparent sandiness is due to comminuted shell-fragments. Its basement-bed consists of a grey gritty stone, full of green-coated phosphatic nodules, which is locally called "brassil." The highest bed is also hard, and is known as the "bond." The stratum thins northward from 15 ft. to 4 ft. The overlying Cherryhinton Chalk also thins northwards and contains no shell-fragments, but in their place numerous isolated chambers of *Globigerina*, like an ooze. The Belemnite Marls are shaly, in two layers, separated hy hard chalk.

Some details are then given of sections along the Newmarket Railway, at Isleham and West Row, in the lower zone,

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[1] It is to be hoped that the full palæontological proofs of these correlations, which do not correspond with those of Professor Judd, will soon be submitted. A work bearing on this has since been published by Professor Pavlov.

and at Landwade, Fordham, West Row, where a pink bed is seen, in the upper zone.

The following fossils have been obtained:—1 = Chalk Marl; 2 = Totternhoe Stone; 3 = Grey Chalk.

Discoidea cylindrica, 2, 3.
Holaster subglobosus, 2, 3.
——— trecensis, 3.
Enoploclytia brevimana, 2.
Glyphæa cretacea, 2.
Pollicepes glaber, 2
Scalpellum maximum, 2
Vermicularia umbonata, 2.
Kingena lima, 2.
Rhynchonella Cuvieri, 3.
——— Mantelliana, 2, 3.
——— plicatilis, 3.
Terebratula biplicata, 2, 3.
——— semiglobosa, 2, 3.
——— squamosa, 1.
——— sulcifera, 2, 3.
Terebratulina gracilis, 2?
Inoceramus latus, 2.
Lima globosa, 2.
Neithea quinquecostata, 2.
Ostrea vesicularis, 1, 2, 3.
Pecten elongatus? 2.
——— orbicularis, 2, 3.
Plicatula inflata, 2.
Teredo amphisbæna, 2.
Turboidea nodosa? 2.
Ammonites Austeni, 3.
——— rothomagensis, 2, 3.
——— varians, 1, 2.
Belemnitella plena, 3.
Nautilus Deslongchampsianus, 2.
——— elegans, 2.
Turrilites costatus, 1, 2?
Cimolichthys lewesiensis, 2.
Lamna appendiculata, 2.
Oxyrhina Mantelli, 2

The Middle Chalk in this district has been described in the Quart. Journ. Geol. Soc. for 1886–7. The Melbourn Rock is 8 ft. thick and is nodular below and thinner bedded above. In the zone above *Rhynchonella Cuvieri* and *Inoceramus mytiloides* are abundant, nodules cease, the beds become more massive, and a few flints set in. The zone of *Terebratulina gracilis* is soft and white, and the flints are in places very numerous. *Echinoconus subrotundus*, *Terebratulina gracilis*, and *Inoceramus Brongniarti* are abundant, and the chalk itself is a nearly pure foraminiferal earth, with many *Globigerinæ*.

Details are then given at Worlington Heath, Mildenhall, Eriswell Fen, and at Lakenham. The fossils noted are:—

Echinoconus subrotundus.
Rhynchonella Cuvieri.
Tererbatula semiglobosa.
Inoceramus mytiloides.
Ammonites peramplus.

Not much of the Upper Chalk is seen, it has usually numerous layers of flint nodules, and beds of flint which are worked for gun flints.

Details are given at Icklingham, 45 ft.; with Paramoudras (locally called gulls) in a second pit; at Elvedon Park, at Shakers Lodge, and at Fornham.

***139. Jukes-Browne, A. J., and Andrews, W. R. —The Lower Cretaceous Series of the Vale of Wardour.**

Geol. Mag., Dec. 3, vol. viii., p. 292.

No Lower Greensand (Vectian) is marked on the Geological Survey Map as occurring in the Vale of Wardour, though its presence was affirmed by Dr. Fitton. A well

sunk at Dinton has now shown its character. This well gave the following section:—

Gault ..	Yellow, brown, and blue clay (with fossils)	21½ ft.
	Containing sandy rock, with a layer of small pebbles at the base (fossils)	14½ ft.
Vectian ..	Brown, grey, and yellow sands, with lumps and layers of ferruginous sandstone ..	26½ ft.
	Light grey sandy clay, becoming darker and passing down into stiff black clay ..	7 ft.
		69½ ft.

One of the ferruginous bands contained *Exogyra sinuata*. The black clay is followed in a brook at Teffont by a nearly black glauconitic sand, resting on mottled Wealden clays. Thus the maximum total thickness of the "Vectian" is 40 ft. The Wealden is perhaps 40—45 ft., and the Upper Purbeck, of yellow and brown clays, 70—10 ft.

***140. Topley, W.—Excursion to Leith Hill.**

Proc. Geol. Assoc., vol. xi., No. 9, p. 163.

The ordinary geology of the district is described.

***141. Jukes-Browne, A. J.—Note on an Undescribed Area of Lower Greensand or Vectian in Dorset.**

Geol. Mag., Dec. 3, vol. viii., p. 456.

The Geological Survey Map, Sheet 15, indicates that the Gault thins out near Shaftesbury, and allows the Upper Greensand to rest on the Kimmeridge Clay. This is not correct, for the Gault continues, and below it a tract of sand forms a feature half a mile wide, near Bedchester, and four or five miles long. A road-cutting at Piper's mill shows 3½ ft. of soil and brown clay (base of Gault ?), and, below this, sands and clays with glauconite 14½ ft.; while a sandpit east of Bedchester shows another 12 ft. of sand, making at least 30 ft. No fossils are recorded.

***142. Monckton, H. W.—Excursion to Guildford.**

Proc. Geol. Assoc., vol. xi., pt. iii., p. 97.

At Littleton are seen: (1) yellow sands, part of 160 ft.; (2) Bargate stone 50 ft., below which are sands. It is a disputed point whether the Bargate stone should be classed with the Hythe or with the Folkestone beds; but the excursionists were unable to decide it.

143. Holmes, W. M.—Glauconite Casts from Godstone Freestone.

Proc. and Trans. Croydon Micr. and Nat. Hist. Club, p. 272.

The Glauconite casts are of foraminifera and other organisms. It is not certain whether these were produced while the material was at the sea bottom, as some sea bottoms exhibit casts and others do not. The silica builds up

spherules in the firestone, which give it its character, and, when these spherules coalesce chert is formed; thus firestone is the immature form of chert.

***144. Jukes-Browne, A. J. — The Geology of Devizes.**

Wiltshire Arch. and Nat. Hist. Mag., vol. xxv., p. 317.

The rocks here seen are described as—

1. *Ironsands*, seen at Rowde and Seend, with few fossils.

2. *Gault*, 80—90 ft. thick, with Lower Gault Ammonites at Dunkirk.

3. *Malmstone*, largely composed of sponge spicules and globules of silica. It is this division that has yielded the numerous fossils in the road cuttings in Devizes. The top bed is used as a building stone, called the Potterne Rock; total 70 ft.

4. *Grey and Green Sands*, 70 ft. thick at Devizes, but thinning out to 3 ft. at Heddington; *i.e.*, they form an east and west sandbank. They contain *Pecten asper*, and are coloured by glauconite.

5. *Lower Chalk* impure and siliceous. Globular silica occurring in the ground-mass, with glauconite grains.

6. *Middle Chalk* with Melbourn Rock at the base and Chalk Rock at the top, with numerous foraminifera; the latter on Oldbury Hill.

7. The Upper Chalk is not exposed near Devizes.

The author's objections to "Lower Greensand" and "Neocomian," and his preference for "Vectian," are then re-stated; and he goes on to point out the equivalence of the Malmstone to the Upper Gault. Thus the chronological significance of "Gault" and "Greensand" is lost. He therefore thinks that a new name, such as "Devisian" or "Sylvanian," is needed for all the rocks between Chalk and Vectian; but he "wishes it to be understood that he is not now proposing any special name."

***145. Strahan, A.—On a Phosphatic Chalk with *Belemnitella quadrata* at Taplow.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 356.

At Lodge Pit, Taplow Court, two bands of brown chalk are seen. The complete section from a neighbouring shaft gives:—

		ft.	in.
Reading beds	Clay	7	0
	Green sand with green coated flints ..	2	6
Upper Chalk	White chalk	18	0
	Brownish white chalk	2	0
	Brown chalk (upper phosphatic band) ..	11	0
	Hard white chalk	12	0
	Soft brown chalk (lower phosphatic band)	4	0
		56	6

Below this in the pit comes the hard rocky chalk and the first flints at 12 ft. down.

The brown chalk analysed by **J. H. Player** gives :—

Moisture	·7
Organic matter	2·3
Lime	53·7
Iron, &c. and alkalies	1·2
Carbonic acid	28·7
Sulphuric acid	0·7
Phosphoric acid	11·6
Silica	0·5
Fluorine	0·7
	100·1

The phosphate of lime amounts to 18 per cent. in the upper and 35 per cent. in the lower bed. The brown colour is due to humic acid, the mean of the analyses given being; Carbon 64·19, Hydrogen 5·67, Nitrogen 3·20, Oxygen 21·64, Ash 5·30 = 100.

When powdered and washed, brown chalk yields foraminifera, *Inoceramus* prisms, amber-coloured fragments, and little oval pellets. Many of these have a varnish-like lustre. Treated with acetic acid, two-thirds dissolve. The foraminifera and the prisms are then seen to be filled with brown material; the chambers are bounded by a clear test, Both these treated with nitric acid yield a precipitate with ammonium molybdate, indicating phosphate of lime. The amber-coloured fragments are pieces of fish-bone and scales, yielding carbonate and phosphate of lime. The pellets are marked like coprolites, and probably come from small fishes. The brown grains when heated and tested with phenol phthalein in many cases turn red all over, indicating an intimate mixture of the organic material. Almost the whole dissolves in hydrochloric acid. The contents of this chalk agree very closely with that of Beauval, but it contains less fluorine. The analysis is almost indentical with that of the Ciply Chalk.

From the absence of exposures of this brown chalk in other sections it is concluded that the chalk has suffered more pre-Tertiary denudation than has hitherto been supposed, and the Taplow chalk is, in fact, an outlier of the upper part.

The figures illustrate the fish-scales, bones, and coprolites, some of the two former being bored by a fungus or alga. Similar borings have been seen by J. Chapman in Gault shells.

***146. Whitaker, W.—Excursion to Selborne.**

Proc. Geol. Assoc., vol. xii., p. 192.

The "hollow lanes" of this district are the result of road traffic, and not of denudation. They are excavated in the "Upper Greensand."

147. Dalton, W. H.—The Undulations of the Chalk in Essex.

"Essex Naturalist," vol. v., No. 5, p. 113, with plate iii.

The Plate is a map, comprising sheets 1, 2, 47, 48 of the Ordnance Survey, reduced to 10 miles to the inch, on which are traced the contour lines of the surface of the chalk below the Tertiary deposits, viz., at 200, 100, 0, -100, -200, -300, -400, -500, -600 above or below sea-level. There is a gradual sinking in a south-east direction from the outcrop near Saffron Walden to the sea at Foulness, where the greatest depth is reached. Two N.E. faults, one running E., and two small cross ones, are marked. There is an elliptical depression S.E. of Chelmsford, and a change of strike between the two main faults, &c. The accompanying paper gives no account of how the information has been obtained, but it is probably from the results of borings.

148. Anon. [C. Griffith.]—**The Geology of the Neighbourhood of Winchester.**

Winchester: J. Wells, 16mo pp. 18, with a Table.

The thicknesses of the Chalk zones in this neighbourhood are:—

1. Belemnitella quadrata, 50 ft.
2. Marsupites, 250 ft.
3. Micraster coranguinum, 100 ft.
4. ——— cortestudinarium, 100 ft.
5. Holaster planus, 40 ft.
6. Terebratulina gracilis, 60 ft.
7. Inoceramus labiatus, 150 ft.
8. Belemnites plenus, 6 ft.
9. Holaster subglobosus, ?

The principal folds are the anticlinals of Kingsclere, Winchester, Portsdown, and the Isle of Wight—all elevated during the Barton Period.

The fossils from 28 localities in the Chalk are given, and the Index contains their general distribution in the zones 1—9, viz.:—

Cliona cretacea, 2, 3.
Scyphia cribrosa, 2.
Siphonia Kõnigi, 6.
Ventriculites alcyonoides, 5, 6.
——— radiatus, 6.
Porosphæra globularis, 1—6.
——— pileolus, 1, 2
——— Woodwardi, 1—3.
Axogaster cretacea, 2.
Parasmilia centralis, 1—5.
Synhælia Sharpeana, 5 or 6.
Trochosmilia cornucopiæ, 1.
Bourgueticrinus æqualis, 2.
——— ellipticus, 2, 3.
Cardiaster pilula, 1,
——— pygmæus, 7.
Cidaris clavigera, 2,3, 5.
——— hirudo, 1—3, 5, 7.
——— perornata, 3.
——— sceptrifera, 2—5.
Terebratulina gracilis, 1, 5, 6.
——— striata, 1—3, 5—7, 9.
Exogyra haliotidea, 3, 5 or 6.
Inoceramus Brongniarti, 6—7.
——— Cuvieri, 3, 4.
——— involutus, 2, 3
——— labiatus, 6, 7.
——— Lamarckii, 6, 7.
Lima globosa, 7 or 8, 9.
——— Hoperi, 3.
Ostrea curvirostris, 1.
——— hippopodium, 3.
——— lateralis, 1, 2, 7.
——— Normaniana, 3, 6.
——— semiplana, 5 or 6.
——— vesicularis, 1, 3, 5, 6, 8.
——— Wegmaniana, 2.
Pecten Beaveri, 8.
——— cretosus, 1—3.
——— jugosus, 2.

Cidaris serrifera, 7
——— subvesiculosa, 2, 3.
Cyphosoma Königi, 3.
——— magnificum, 5.
——— simplex, 5.
——— spatuliferum, 3.
Discoidea minima, 6—8.
Echinoconus abbreviatus, 3.
——— conicus, 2, 3, 7.
——— globulus, 7.
——— subrotundus, 6.
Echinocorys gibbus, 1—5.
——— gigas, 5.
——— scutatus, 1.
Epiaster gibbus, 3.
Nymphaster angustatus, 2.
——— Coombii, 6.
Calliderma latum, 2, 5.
Astrogonium lunatum, 3.
Goniaster Parkinsoni, 2.
——— rugatus, 2, 5.
——— uncatus, 1.
Holaster planus, 5.
Marsupites testudinarius, 2.
Micraster breviporus, 3, 5.
——— cor-anguinum, 2, 3, 5.
——— cor-bovis, 5.
——— cor-test., 3, 4.
Oreaster bulbiferus, 2.
Serpula ampullacea, 2.
——— annulata, 5, 6.
——— plexus, 1, 3.
Pollicipes glaber, 5.
Ceriocava ramulosa, 3.
Flustra inelegans, 1.
Idmonea cretacea, 1.
Lunulites cretaceus, 1, 3.
Petalopora pustulata, 1, 2.
Crania egnabergensis, 1.
——— parisiensis, 1.
Kingena lima, 1—3.
Rhynchonella Cuvieri, 5—8.
——— limbata, 1
——— Mantelliana, 9.
——— plicatilis, 1, 2—7, 9.
——— reedensis, 2, 5, 6.
Terebratula carnea, 3, 5, 6.
——— obesa, 3.
——— semiglobosa, 2—7.
Pecten orbicularis, 9.
——— quadricostatus, 3.
——— quinquecostatus, 1—3, 9.
Plicatula pectinoides, 9.
——— sigillina, 3, 7.
——— spinosa, 9.
Spondylus Dutempleanus, 1—3, 5, 6.
——— latus, 1—3, 5, 6.
——— spinosus, 1, 3—6.
Modiola quadrata, 5.
Teredo amphisbæna, 7, 9.
Avellana cassis, 5.
Pleurotomaria perspectiva, 5, 6.
Rostellaria stenoptera, 5.
Trochus cirrus, 5.
Turbo gemmatus, 5.
Ammonites Bravaisianus, 5, 6.
——— Cunningtoni, 7.
——— Mantelli, 7.
——— navicularis, 7.
——— peramplus, 5 or 6, 7.
Aptychus leptophyllus, 2.
Baculites bohemicus, 5.
——— Faujasii, 5.
Belemnites plenus, 8.
Belemnitella lanceolata, 1.
——— quadrata, 1.
——— vera, 3.
Hamites angustus, 5 or 6.
Scaphites æqualis, 5.
——— costatus, 5, 6.
——— Geinitzi, 5.
Beryx radians, 6.
Cimolichthys lewesiensis, 1, 7 or 8.
Corax heterodon, 5—8.
——— pristodontus, 7.
Enchodus lewesiensis, 1, 2.
Macropoma Mantelli, 7.
Notidanus microdon, 7 or 8.
Odontaspis rhaphiodon, 3, 6.
Otodus appendiculatus, 5, 6, 7 or 8.
Oxyrhina Mantelli, 2, 3, 5, 6, 7, 9.
Protosphyræna ferox, 1, 6, 7.
Ptychodus decurrens, 7, 8.
——— latissimus, 3.
——— mamillaris, 3, 7.
——— polygyrus, 3, 6.
Pycnodus cretaceus, 7
Polyptychodon interruptus, 7 or 8

TERTIARY.

***149. Leighton, T., and Ogle, J. B.— On Some Recent Sections at Dulwich.**

Proc. Geol. Assoc., vol. xii., pt. i., p. 8.

This describes a section in a trench running N. by E. from the curved road passing under the L. B. & S. C. Rail-

way from Half-Moon Lane. It shows, beneath an irregular covering of brick-earth and gravel, three beds of the Woolwich and Reading series, viz., mottled clay up to 1 ft. 9 in.; a shell bed of constant thickness, 3 ft. 4 in., made of *Cyrena*, with a few *Melaniæ*; a sandy bed, not fully seen, beneath which is reported a harder shell bed not seen *in situ*: the dip is about 1 in 72, slightly north of east. A filled-up stream bed is noted, and also a "pipe," 4 ft. 4 in. across at the top, and filled with gravel and sand, surrounded by tenacious clay. This part of the series had not been previously described in this district.

***150. Holmes, T. V.—Excursion to the Cutting near Shortlands Station on the Nunhead and Shortlands Railway.**

Proc. Geol. Assoc., vol. xii., pt. iii., p. 92.

In this cutting, below a pebble bed 4—5 ft. thick, belonging to the Blackheath series, is—1. Clay, with *Cyrena*, &c., sometimes mottled at the base, 8 ft. 6 in.; 2. White sand, with black flint pebbles, 4—5 ft.; 3. Green sand, with pebbles, 7 ft. 6 in. This shows that in this locality the Woolwich and Reading beds were not eroded away before the deposition of the Oldhavens, as is sometimes the case elsewhere.

***151. Whitaker, W.—Excursion to Upnor.**

Proc. Geol. Assoc., vol. xii., p. 190.

A general section of the Eocene beds here is given.

***152. Irving, A.—Recent Contributions to the Stratigraphy of the Later Eocenes of the London Basin.**

Wellington College, pp. 16.

This is a separate publication, with additions, of a paper read to the Geological Society on June 10th, *see* No. **153.** It consists of details of various excavations made to prove the accuracy of the author's statements of Nov. 12th, 1890, which had been impugned. Samples of the materials collected have been subjected to mechanical analysis by elutriation, so as to determine the relative amounts of coarser and finer material, *i.e.*, of sand and clay. The first series of excavations was made in a strip of land between the South Eastern Railway and the Wokingham-Sandhurst Road, from Wellington College Station to Nine Mile Ride. The result is to show that, where the author had expected to find clay, the beds he so named never contain more than 35% of sand; while the lower part of the series at Silverstock contains no clay. He has also sunk a pit outside the railway fence, south of Nile Mile Ride, which shows 5 ft. of gravel lying on quartzose sands, showing the latter not to be so thick as stated by his opponents.

From these data he concludes: (1) that his corrected section is proved; (2) that beds mapped as i. 4 by the Geological Survey are continuous, and in alignment with beds mapped as i. 5, further west and east; (3) that the lower quartz-sand series thins northward; (4) that the green earths of a higher level thin from 36 ft. to 18 ft. in a mile, and therefore probably die out.

The second series of excavations lie east of the new road from Wellington College to Wokingham, and shows clays with a maximum of 17·75 % of sand, where he had mapped them. His general conclusion is that the Survey Map "is altogether erroneous for the country near the South Eastern Railway." It is by accepting this as the basis of their work that his opponents have been led into error.

He gives also, in Note C, the essential evidential matter of his paper of Nov., 1890. 1, Pipe-clay, false-bedding, and mica are not a criterion of Lower Bagshot Sands, for the most micaceous beds he has seen are in a new well high up in the Bracklesham series, and in five well sections along the northern margin no clay is recorded from the Lower Bagshot Sands; 2, three well-sections are given; 3, sketch section from Ambarrow to Barkham Hill, showing the constant position of a pebble bed at the same level. At Dowle's Farm the quartzose sands contain a band of pipe-clay; 4, a section of the sand pit at the brick-yard at Nine Mile Ride is given.

***153. Irving, A.—Note on some Recent Excavations in the Wellington College District.**

Proc. Geol. Soc., p. 171.

This is published in full by the author (see No. **152**).

***154. Hudleston, W. H.—Excursion to West Surrey.**

Proc. Geol. Assoc., vol. xii., pt. iii., p. 100.

It is difficult to understand why the top of St. Anne's Hill was marked Lower Bagshot in the old Survey maps, or why a fault should be placed at the bottom in the new ones. It is doubtful whether there are any good grounds for separating the clays of the Lower Bagshot from the clays at the base of the Middle Bagshot—so that the location of the clay in the Hatch Brickyard is a matter of indifference.

***155. Irving, A.—Physical Studies of an Ancient Estuary.**

Geol. Mag., Dec. 3, vol. viii., p. 357; Rep. Brit. Assoc. for 1890, p. 818.

The Bagshot Beds of the London Basin are in the main a mixed series of fluviatile, terrestrial, and estuarine deposits, the last term indicating the access of the tides to the river deposits. This involves a slow subsidence of the area with intermittent pauses of long duration. The key to the

physical history of these beds is the organic origin of the green colouring matter. By the decay of vegetation, various salts of iron are formed, the non-metallic constituents of which, on exposure to the atmospheric oxygen, pass into carbonic acid and water, while the ferruginous are precipitated as iron oxide. The glauconite is probably formed by the action of the organic acid on the silica in the presence of strong bases. In this way, the lagoon origin of the middle group is testified to. False-bedding, and bands of pipe-clay, are indications of the alternation of conditions; the latter may be derived from the argillaceous matter in the chalk by the solvent action of humus acids upon the carbonate of lime, as has been demonstrated by the experimental action of dilute acetic acid. Neither of these phenomena are, therefore, characteristic of horizons, though massive clay deposits are only found in the middle group. The freshwater diatoms and the rounded Eolian sand grains testify to the same conditions, and the thin seams of very pure clay in the green earth series point out the deeper parts of the lagoons, the thinning out observed defining their original boundaries. He adheres to his classification of the Bagshots, given in 1887, into an Upper Marine-Estuarine series and a Lower Freshwater series, in place of the usual Upper, Middle, and Lower, and points out that the presence of bands of marine shells, most of which are abraded or broken, is quite compatible with the estuarine character of the whole. He cannot agree that the fauna of the Upper Bagshots indicate "an open sea of considerable depth," he considers it is characteristic of a shallow salt-water estuary, and the force of a tide on the shore line is necessary to account for the masses of discoid pebbles. There is not much interval of time between the Upper Bagshots and the Lower beds, as is testified by the community of their faunæ.

***156. Irving, A.—Excursion to Wokingham and Wellington College.**

Proc. Geol. Assoc., vol. xi., No. 9, p. clvi.

This was devoted to a demonstration, as far as time permitted, of the facts on which the author's views are founded.

The unconformity stated to occur between the Bagshot Beds and the London Clay does not appear to have been further demonstrated than by their line of junction being traced across St. Paul's Churchyard at Wokingham, and compared with sections on the railway just below. In the Holt, a strong clay was shown "nothing like to which occurs . . . . on the north side of the Bagshot district below the basal clays of the (author's) Middle Bagshot." The London Clay crops out 15 ft. below the base, so the quartzose sands between represent the attenuated Lower sands; at Tangley 10 ft. of

this sand is seen. In Nine Mile Ride, the clays are seen as far as California, and the 50 ft. of sands at Buckhurst Hill above must belong to the Upper Bagshot. In Lawrence's Brickyard the quartz sands are seen at the base, and the clays above are worked for bricks. The glacial section, showing once frozen gravels forced into the clays as at Tangley [see No. **274,** 1890] was also shown here. In the road leading to Wellington College the succession of beds as traced in the well section was seen.

***157. Colenutt, G. W.—Notes on the Geology of the North-East Coast of the Isle of Wight.**

Papers and Proc. Hampshire Field Club, vol. ii., pt. i., p. 20.

This gives an account of the coast section from East Cowes to St. Helen's Church, along which the Osborne and Bembridge Beds undulate. Near East Cowes the Headon Beds are brought up in an anticlinal, and here numerous Cyprids, *Lamna*, *Cyrena*, and *Cerithium concavum* are found. The fallen pieces of Osborne Limestone are often full of *charæ*. Below Chapelcorner Copse, between Woodside House and Wootton Creek, an excellent section is seen. About 3 ft. of Bembridge Limestone caps the cliff, and below this is seen :—

In the Cliff:—

1. Marls and yellow grey, dark red and mottled clays, about 40 ft.

On the Beach:—

2. Grey clay, with scattered fish bones, &c. .. .. 4 „
3. Hard blue and grey shaly clay with *Clupea vectensis* and *Palæmon* .. .. 2 „
4. Hard grey clay with matted masses of leaves and lenticular masses of cement stone .. .. .. 3 „
5. Blue clay, with many seams of crushed *Paludina lenta* and *Melanopsis carinata* .. .. 6 „
6. Unfossiliferous green and mottled clays to low-water mark.

In No. 2 the fish-bones, *Lepidosteus*, are in small masses in which there are also *Alligator*, *Emys*, *Trionyx*, *Platemys* and a rodent—*Therdomys*.

No. 3 is a very characteristic deposit; the *Clupea* bed is about 6 in. thick, and is visible in several places. East of Binstead Brook it rises into the cliff, and the Osborne limestone, below all the above section, is seen to be ripple-marked. At Sea View there are two beds of this, the lower 8 ft. thick; and to the east of Sea View Pier the fish bed occurs again, thus ranging over five miles.

At Horestone Point the Osborne limestone contains lines of small flint pebbles, beyond which comes Priory Bay, where Forbes described the St. Helens sands, which is a distinct facies of the Osborne beds. Half way up the cliff is the Bembridge limestone in three bands, and about 6 ft. above the highest is the bed which at Gurnard has yielded

insects; and further on, the series descends so that the Bembridge limestone forms a reef.

***158. Reid, C.—Geology of the Crag District, and of the Coasts of Norfolk.** [In French.]

Compte Rendu Congrès Géologique International (1888), p. 417.

The description appears to follow on already published lines, particularly that of the Geological Survey memoir by the author. A bibliography (by **W. Topley**) is given, and Searles Wood and Harmer's map is reproduced.

***159. Gunn, John.—The Cromer Forest Bed and its Fossil Mammalia, with Some Account of the Associated Strata in the Cliffs of Norfolk and Suffolk.**

"Memorials of John Gunn," p. 45. *See* No. **306.**

A posthumous paper, edited by H. B. Woodward; gives a general account of the series at Cromer and its neighbourhood, with historical notes and a memoir of the author.

The Forest bed had been thought to be a homogeneous formation, till in 1860 whales' vertebræ were found in it. It was then recognised that this, the lower portion, was estuarine, though containing *Elephas meridionalis*. In the same blue clay at Bacton many deers' antlers have been found. The associated gravel Mr. Gunn called the Elephant Bed. The estuarine bed has been traced as far as Beeston on an eroded surface of the Chalk.

The real "Forest Bed" is above this, and represents the land surface after the estuary had been raised. It is here that the *Trogontherium*, *Ursus*, *Arvicolæ* and two elephants occur, and in which fern leaves and tree stumps are found. Some at least of these, he is convinced, grew *in situ*, having tap roots, and the cones and leaves surround them. The Forest Bed at a later date was submerged and reconstructed, as seen at Happisburgh and Paston, and was followed by lacustrine beds with remains of *Myogale*.

The Unio Bed and the Rootlet Bed are two of the final phases. The last of the series were the "Laminated Beds," with whale, walrus, and seal.

Figures are given of many of the mammalian remains preserved in the Norwich Museum.

160. Various Authors.—Discussion on the Limits of the Tertiary and Quaternary.

Compte Rendu Congrès Géolog. International (1888), p. 233.

Renevier, E., prefers "Pleistocene" to Quaternary, as no new organic type is introduced except doubtfully—man.

Lapparent, A. de, and **Gaudry, A.,** think the appearance of man sufficient to place the Quaternary on a level of importance with the other three divisions.

Sacco, F., thinks the great seismic movements, and change of climate at the close of the Tertiary, additional reasons for separating the Quaternary.

Blanford, W. T., is against Quaternary, and would divide the Tertiary into two systems.

Gosselet, J., considers the Quaternary as the epoch of the erosion of the present valleys.

Evans, J., and **Pilar, G.**, think the term Quaternary at least useful in co-ordinating facts.

Lapparent, A. de, says the Quaternary is also marked by explosive vents instead of fissure eruptions, by the cessation of the organic formation of limestones, and by the importance assumed by glaciers.

Prestwich, J., also desires a distinct name for the epoch of man's appearance, and for changes of climate, but prefers Pleistocene.

GLACIAL AND SUPERFICIAL.

161. Kendall, P. F.—Hints for the Guidance of Observers of Glacial Geology.

Stockport: 12mo, pp. 55. 1s.

This is issued by the North-West of England Boulder Committee, and is printed on one side of the paper only. It states the exact items of information which are desired, so that by reading it on the ground the details, which might otherwise be overlooked, may be noted.

It deals with boulders, striated surfaces, the deposits, the surface configuration of Drift deposits, the stones embedded in glacial deposits, the shells, and the features of rocky hills and valleys.

A few notes are finally added as to the best field equipment.

*162. Goodchild, J. G., &c.—The Geology of the Country around Mallerstang.

Mem. Geol. Surv., chap. xv.

The principal masses of Drift here occur on lower ground. Nevertheless, it reaches in places as high as 1,400 ft., and a thickness of 50 ft. in one place is mentioned. The thickest and widest deposits occur on slopes that face away from the source whence the material came. In the flat valley of the Ure the drift stands in isolated mounds, called "drumlins," the solid rock being sometimes seen between. On Long Gill there is local drift even up to 2,000 ft. The Longstone Fell shows a drift which must have travelled from the east, but turned south before reaching the Silurian area. In the

valley of the Swale there are long mounds, with the axes parallel to its length, and these appear to be rendered more conspicuous by the parallel erosion of the underlying shales. Neither in Swaledale, Wensleydale, nor Mallerstang are there any boulders foreign to the district; but they are derived from beds in the valley at a lower level to the south, showing that the motion must have been uphill to the north, perhaps owing to ice on Shunner Fell.

Several instances of striated rocks are mentioned—amongst them a boss on the Midland Railway, 1 mile south of Hawes Junction, which has striæ running from S.W. to N.E. The top of Baugh Fell, though 2,200 ft. above sea-level, shows *roches moutonnées* 100 yards long, polished like glass; the striations running S.W. and N.E., but in which sense is uncertain here. The ice moved probably down the larger dales, in the lines of the present drainage; but, in the upper part of the basin of the Swale, where the streams flow south, the ice moved east across the present drainage into the valley of the Tees, and it also flowed over from Garsdale into Wensleydale.

In some valleys, as in Swaledale, there are later river terraces.

***163. Bulman, G. W.—On the Origin of the Upper Drift Sands and Gravels of Northumberland.**

"The Naturalist" for 1891, p. 43.

These sands and gravels lie upon the surface of the Boulder Clay, and consist of rounded stones, with bedding suggestive of river action. It is therefore concluded that they were produced when the Glacial Period was terminating, and the melted ice caused rapid rivers to flow from the heights over the clay-covered low ground, and so clear out most of the moraines from the higher valleys and deposit the material irregularly over the lower ground.

164. Pearce, H.—Personal Observations of Glacial Action among British Mountains.

"The Midland Naturalist," vol. xiv., p. 77.

At the upper end of Hawes' Water, 1,383 ft. above O.D., are some beehive-shaped mounds of drift. Above Brother's Water, on either side of Red Screes, are numerous little moraines. He thinks Nabs Scar, Rydal, was cut off by a glacier, and notes a boulder in Dove Dale Glen, the smooth surfaces of Borrowdale and some moraines in Deepdale. In North Wales he notes ice scratches in Cwm Orthin Ffestiniog, in the valley of Artro above Llanbedr, and in the Pass of Drwys-y-coed, Snowdon.

***165. Lamplugh, G. W.—On the Drifts of Flamborough Head.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 384, plate xiii.

The area east of a line from Bridlington to Speeton has a high northern boundary, capped by a range of gravel hills which cross the promontory where it descends to a lower level. Parallel and inland to this range is a depression called the Bempton Valley, and parallel again to the south is the Gypsey Race.

The sections described are:—

a. Bridlington Quay.—The lowest visible rocks are "Basement Clay," but a boring on the foreshore has shown chalk rubble at 20 ft. below. Where the clay is highest in the cliff, the shell bed occurs as a boulder. Above comes laminated clay, and then brown clays with intercalated gravels. The uppermost portion is identical in character with the "Hessle Clay."

b. Potter Hill.—This is between the Bridlington and Sewerby sections, and the cliff is seldom clear; but after storms it is seen that "the basement clay does not die out, as had been supposed, against the rising slope of the chalk, but, after continuing for half a mile on the foreshore between tide-marks, rises again into the cliff and mounts, by a long slope, to the top of the Chalk." [1] The Purple clay shreds out into gravels.

c. Sewerby.—Here the basement rubble is seen, capped by two Boulder clays and a later gravel.

d. The Buried Cliff.—The solid chalk appears suddenly in a cliff 30—40 ft. high, it is of pre-Glacial erosion, at the same level as to-day. Banked against it are—at the base, an old sea-beach, 4 or 5 ft. deep; then a rainwash or marly clay and chalk, with land-shells and bones, 0—5 ft.; and then a 25 ft. mass of wind-drifted yellow sand, the cliff against which it rests being smoothed by the friction. [Fig. 94.]

e. Sewerby to Danes Dyke.—Here we get the chalk rubble at the base, the Lower Boulder Clay tends to run off into gravels, and the Upper Boulder Clay is sometimes stratified at its base. The overlying Sewerby gravels contain dark drift-pebbles below, and much white chalk above.

f. Danes Dyke.—Stratified chalky gravels and sand are developed above and below the Basement Clay, and also in the Upper Clay, and at last usurp the whole thickness, but the Boulder Clay soon reappears in bands, and the mixture occupies the ravine at an outlet of the Bempton Valley. Fragments of *Saxicava norvegica, Cardium greenlandicum, Nucula Cobboldiæ, Tellina balthica,* &c., occur in the clay. All above he considers to represent the "Purple Clay." The chalk

[1] This appears to settle the main disputed point.

below is contorted, and the rubble on it contains a quartzite boulder.

g. Hartindale Gutter. — Eastward the gravels die out, and there are only two Boulder clays with a stratified band between. At the Gutter the drifts are seen to die out inland, and in the cliff face only one Boulder Clay occurs.

h. Beacon Hill is a ridge of the gravel mounds (terminal moraine of Carvill Lewis). It consists of "a lower dark Boulder Clay, an intermediate series of more or less stratified material," sand, clay and warp, "and an upper brown or red Boulder Clay, often discontinuous over the crest."

i. South Sea Landing.—On the west side is seen a drift-filled hollow, with coarse rolled gravel at the base, and above it a thick mass of well-bedded sand, silt, and fine gravel. On the east side there is nothing but a mass of rough chalk rubble, *apparently* 40 ft. thick, mingled with Boulder Clay, probably formed when the outlet was blocked. The shell bed near here is discussed in No. **261**, 1890.

k. South Sea Landing to High Stacks—The drifts vary in thickness from 30 to 60 ft., of two Boulder Clays, the lower of which, and once the upper, change to gravel, which thickens in places and forms mounds. Beyond this the drifts vary from 12 to 60 ft., and are very chalky at the base.

l. High Stacks.—The section here intersects the prolongation of the Bempton Valley, and the sea has undermined the chalk and made a "blow hole," the section of which shows dark Basement Clay with shell fragments 25 ft., gravel with a band of Boulder Clay 30 ft., overlaid by brown Boulder Clay.

m. Pigeon Hole, is another "blow-hole" showing thick sands at the base, Basement Clay with a *remanié* mass of Speeton Clay and shell fragments, rough chalkless gravel, and Upper Clay at the top.

n. Selwicks.—Here the valley side is quite cut through, and the Chalk shows contortions due to glacial action.

o. Stottle bank to North Sea Landing.—At first the drifts consist chiefly of Boulder Clay, with flints differing from those of the Chalk below. But at North Sea Landing there is a hollow filled with well stratified silty beds, resting on thick chalk rubble. The Upper Clay is continuous on the clifftop, which is remarkably level.

p. Thornwicks.—Two other hollows show a coarse morainic gravel above the chalk rubble, and the Basement Clay and its gravel have yielded perfect yet transported specimens of *Trophon antiquum* and *Tellina balthica.*

q. Sanwick shows a section of a gravel mound of the usual character.

r. Bempton and Buckton.—The drifts thicken and thin inde-

pendently of the slope and height of the ground, and where thickest the two Boulder Clays can be distinguished. They die out inland almost completely.

s. Speeton.—On the slopes are pre-Glacial slips, and at the foot the same two Boulder Clays as above, the older of which would have been eroded had there been an inter-Glacial period. Beyond the Gap there is an estuarine shell bed of sand and silt 16 ft. thick, the top being 90 ft. above high water; it is overlain by chalk rubble, 10 ft. of Basement Clay, 5 ft. of sand and gravel, and 30 ft. of brown Boulder Clay. This shell bed is probably the earliest of all the deposits.

t. Filey Bay.—Here are three or four Boulder Clays with large transported masses of Lias, &c.

u. Inland of Flamborough Head shows very little drift, and here and there local chalky gravels, probably of freshwater origin.

For the Boulders found here see No. **305**, 1890, also No. **422** of this volume.

The classification is then discussed.

1. "*Infra-Glacial*" *Beds.*—These at Sewerby have yielded *Elephas antiquus*, *Rhinoceros leptorhinus*, *Hippopotamus amphibius*, *Cervus*, *Bison*, *Hyæna*, *Arvicola amphibius*, *Gadus Morrhua*, also *Helix hispida*, *H. pulchella*, *Pupa marginata*, *Zua subcylindrica*, and *Purpura lapillus*, *Littorina littorea*, *Ostrea edulis*, and *Mytilus edulis*. The Speeton shell bed yields *Tellina balthica*, *Scrobicularia piperata*, *Cardium edule*, *Mytilus edulis*, *Littorina littorea*, *L. rudis*, *Hydrobia ulvæ*, *Utriculus obtusus*, *Rhynchonella psittacea*. There is nothing specially pre-Glacial in these, and there are drift pebbles in the gravel, but not of mountain limestone. They are the commencement of the Glacial series, and nothing older is known in Yorkshire. They may be parallel with the *Leda-myalis* bed of Norfolk.

2. *The Chalky Rubble* is the result of weathering in a severe climate before the arrival of the ice-sheet, and where it did not extend.

3. *The Basement Clay* is the product of land ice coming up out of the bed of the North Sea. No evidence of any earlier glaciation is known, though there are great depths below its summit in Holderness, and the presence of shell patches and boulders of Secondary rocks shows that the ice which carried it passed over a bare floor.

4. *The Intermediate Series and Purple Boulder Clay.*—Broadly speaking, the great mass of the Purple Clay of Holderness may be said to resolve itself in the Flamborough sections into stratified deposits, and he believes that a section east and west across Holderness would reveal the passage of the Purple Clays of the coast into the inland gravels of the mounds. The marine shells are in fragments and in the

gravels only, and have been brought by the ice. The stratified deposits are due to the washing of morainic material during the period of recession at the margin of the right wing of the great glacier, whose main direction was southerly. The beds further south may possibly have been formed in the sea.

5. *The Upper Boulder Clay* he considers the result of northern land ice brought coastwise while the North Sea was blocked with old ice, which spread beyond the former limits owing to an increase in the quantity. This ice melted *in situ* when the North Sea ice departed. It is the equivalent of the Hessle Clay.

6. *The Sewerby Gravels* were deposited at about the same period as the Upper Clay. The "Gypsey Gravels" are still later.

He finally suggests that the three divisions here may be equivalent to the three elsewhere, *e.g.*, that the Basement Clay = Cromer Till, the Intermediate series = the Contorted Drift, and the Upper Boulder Clay = the Chalky Boulder Clay. There is no evidence that the ice was interrupted by an inter-Glacial period.

***166. Lamplugh, G. W.—East Yorkshire during the Glacial Period.**

Rep. Brit. Assoc. for 1890, p. 798.

A short *résumé* of the conclusions formulated at the close of No. **165**.

***167. Lamplugh, G. W.—Final Report of the Committee . . . . appointed for the Purpose of Investigating an Ancient Sea Beach near Bridlington.**

Rep. Brit. Assoc. for 1890, p. 375.

The following is the complete list of organic remains found in the beds at the "Buried Cliff." (1) Old Beach, (2) Rainwash, (3) Blown Sand.

Elephas antiquus (1), (3).	Helix hispida (2).
Rhinoceros leptorhinus (1).	—— pulchella (2).
Hippopotamus amphibius (1).	Pupa marginata (2).
Bison (1), (2), (3).	Zua subcylindrica (2).
Hyena crocuta (1), (3).	Purpura lapillus (1).
Arvicola amphibius (2).	Littorina littorea (1).
Birds (1), (2).	Ostrea edulis (1).
Gadus Morrhua (1).	Mytilus edulis (1).

The pebbles of the beach consist (per cent.) of—Carbonaceous Shale, 10; Sandstones, 25; Quartzites, 20; Palæozoic Conglomerates 3; Vein Quartz, 4; Basalt, 17; Felsites, &c., 13; Granite, 2; Oolite, 4; Flint (not local), 2. It is specially noted that there are no Carboniferous Limestone pebbles, and as a whole the pebbles seem to have come from greater distances than those in the Boulder Clay.

***168. Cole, E. M.—Peat Deposit at Filey.**

"The Naturalist" for 1891, p. 17; Rep. Brit. Assoc. for 1890, p. 823.

A section on the top of the Boulder Clay cliffs now shows 6 ft. of peat resting on a bed of stiff, pearly-grey clay, 2 ft. thick, and underneath this another bed of peat. This is the centre of a small lake now dried up, the edge of which was noted by Phillips 60 years ago, before denudation had proceeded so far as at present, and it resembles similar ones in Norway. Mosses, Desmids, Diatoms, &c., and other small remains have been noted and named.

169. Holgate, B.—A Long-Buried Oak.

Trans. Leeds Geol. Assoc., pt. vi., p. 47.

In the yard of Messrs. Tetley's Brewery, Leeds, an oak trunk has been found 23 ft. in length, decreasing in diameter by only 6 in., which indicates a length of 100 ft. originally. The angle at which the branches diverge indicate that it grew in a dense forest, and it is believed to be 600 years of age. There must thus for many centuries have been dense forests in the valley of the Aire.

170. Kendall, P. F.—On the Glacial Phenomena of the Isle of Man.

Rep. Brit. Assoc. for 1890, p. 807.

The Ramsey Brooghs show two beds of Boulder Clay, separated by false-bedded sand. Beyond Dog Mills is a true beach in a cliff of 200 ft., probably younger than the Ramsey Beds. Beneath it is a shelly clay. At the mouth of Ballure Glen a varied series of glacial deposits is bedded at a high angle against the slates. The cliffs near Kirkmichael are like those near Dog Mill, and at St. John's shelly sand occurs. In the Ramsay and Kirkmichael deposits stones from the Lake District and Scotland occur, but none from the island itself. Some scratched stones occur on Snaefell at 1,400 ft. In the South, Foxdale granite has been lifted 800 ft. above its outcrop, but no foreign stones occur at high altitudes.

Of the shells, *Nassa pliocena*, Strickl. = *N. serrata*, Brocchi. *Fusus Forbesi* is not = *F. cinereus*. He has also found *Cemoria noachina*, and Mr. Kermode records *Columbella sulcata* of the Crag. These, however, may be *remanié*.

***171. Morton.—Geology of the Country around Liverpool, p. 181** [*see* No. **91**].

An account of the Ffynnon Beuno and Cae-Gwyn Caves is first given, and then a list of the striæ in the district. * = new records.

North Hill Street, N. 35° W.	Old Swan, *N. 37° W.
Boundary Street, N. 15° W.	Knotty Ash, *N. 35° W.
Stanley Road, N. 15° W.	Crosby, N. 40° W., W. 43° N.
Park Hill Road, N. 42° W.	Little Crosby, N. 22° W.

Miller's Bridge, Bootle, N. 28° W.
Christ Church, Oxton, N. 24° W., N. 22° W., and N. 40° W.
Poolton, N. 19° W., N. 27° W., N. 30° W., N. 32° W., N. 38° W., N. 44° W.
Wallasey, N. 30° W., N. 32° W.
Flaybrick Hill, N. 30° W., N. 20° W., N. 32° W., *N. 12° W., N. 10° W., N. 22° W., W. 30° S.
Wavertree, N. 32° W.
Pool Hall Rocks, N. 43° W.
Hilbre Point, *N. 12° E.
Thatto Heath, W. 40° N.
Middlehurst Delf, St. Helens, W. 33° N.
Crank, St. Helens, W. 30° N.
Garswood, St. Helens, W. 30° N.
Farnworth Church, W. 8° N.
Appleton, W. 8° N.
Runcorn, W. 8° N.

The scattered distributions of these localities he thinks best accounted for by the frequent grounding of icebergs and field ice.

The Glacial deposits are classified as:—

1. Lower Drift Sand, chiefly known in borings.

2. Lower Boulder Clay, of red colour, and with numerous fragments of local rocks.

3. Middle Sands—very irregular, yellow, current-bedded.

4. Upper Boulder Clay, brown, and contains boulders up to 7 ft. long.

Most of the boulders are of Silurian rocks, and local ones are rare. Fragments of *Turritella terebra* are found.

5. Upper Drift Sand occurring in hollows of the Clay.

Sections are given in which these are, or have been, well seen, as at Linacre, South Shore, Alexandra Dock, Codling Gap near Egremont, Dawpool near West Kirby, and Burscough Bridge, at which (1) is 21 ft., (2) is 66 ft., (3) is 90 ft., (4) is 63 ft. thick.

A hundred boulders have been examined from (1) Stanley Brick Pit, (2) Mowbray Brick Pit, Great Crosby, and the proportion of the different rocks determined.

Greywacké, possibly Coniston Grit	27—30
Felspathic Ash and Felstone, Lake District ..	11—19
Basalt, &c.	17—11
Diorite and Gabbro, Wigton and Mull	6—6
Granite and Syenite, various	14—15
Mica Schist, perhaps Galloway	3
Quartzite, &c.	11—3
Carboniferous Limestone	4—5
Carboniferous Sandstone	3—3
Local Trias	4—8

A list of 53 shells from the Drift, including 16 from Cae-Gwyn Cave is given, all of which now inhabit Liverpool Bay except *Leda pernula*, *Astarte compressa*, *Astarte borealis*, *Venus Chione*, *Saxicava norvegica*, *Natica affinis*, *N. greenlandica*, *Pleurotoma Trevelyana*.

The post-Glacial deposits consist of an Upper Peat and Forest Bed, Grey Clay, Sandy Silt, and a Lower Peat and Forest Bed. These are often found below low-water mark

in excavations, or exposed between that and high-water. Details are given at Wallasey Pool, Leasowe, Hoylake, Bootle, Langton Dock, Hightown, and the Alt mouth, and sections from Ellesmere to Ince Ferry.

He calls attention to the remark of Sir J. A. Picton, that as there are Roman stations on the other neighbouring rivers and not on the Mersey, this river, *in its present form*, probably did not exist in Roman times. The river must have always been there, but not the estuary, which has been produced by a depression which has submerged the forest beds, and of which the last result was the inundation of Stanlow Monastery in 1279.

***172. Paul, J. D.—Recent Geological Notes.**

Trans. Leicester Lit. and Phil. Soc., vol. ii., part ix., p. 405.

A hill called Beaumont Leys has been utilised as a sewage farm, but not successfully, as it is covered by Boulder Clay. This Boulder Clay is a double deposit; the upper part contains rocks from the east, the lower part rocks from the north and west. Below there is a bed of sand about 20 ft. thick. The lower part of this is indurated into a sandstone, which stands up in pillars, due to the percolation of calcareous waters; one of these after removal of the sand was known as St. John's Stone.

He notices also that native copper has been found in Bardon Hill Quarry, and a well in Vestry Street goes down 200 ft. in the Keuper.

***173. Barke, F.—Report on Geology.**

Ann. Rep. and Trans. N. Staffordshire Nat. F. C. for 1891, p. 19.

The Boulder Clay in the Potteries is not in isolated patches, but in a continuous sheet which rises above the 600 ft. contour at Hanley and Tunstall. The Boulders are probably from the Lake District and the local Carboniferous rocks. In the associated gravels there are a few chalk-flints.

***174. Hind, W.—Notes on a Pre-Glacial River-bed at Stoke Road, Shelton.**

Ann. Rep. and Trans. N. Staffordshire Nat. F. C. for 1891, p, 53, with two plates of sections.

In a section 200 yards long, made for sewerage in Hayward, Boulder Clay is seen to thin out from 4 ft. and then thicken again to 18 ft., overlying Coal-measure Sandstone. Below the Boulder Clay were 4 ft. or more of peat and river gravel. In another section, 50 yards to the east, there was only an inch or two of this gravel. At the Board School in Cauldon Road, below 7 ft. of Boulder Clay, was current-bedded river sand free from gravel, but in the Cauldon Road itself were two beds of Boulder Clay, but no sand. These limited deposits of sand were thus pre-

Glacial, and show that the Trent valley is also pre-Glacial in origin.

***175. Whitaker, W.; Bennett, F. J.; and Skertchly, S. B. J.—The Geology of Parts of Cambridgeshire and Suffolk.**

Mem. Geol. Surv., chaps. v.—viii.

Beneath the Boulder Clay in this district are some masses of loam. These are described in miscellaneous sections recorded in old notes, mostly by the second and third authors, some dating from 1876. These sections are mostly now destroyed, and cannot be verified. The principal places are Barton Mill; Juddenham; Lackford; Flempton; Fornham; Culford, where a flake was found; West Stow; Wordwell; Ampton; Brandon Park; Elvedon Gap, where the deposits are in a trough; Barnham; Mildenhall; Warren Hill, where the sand and brick-earth form a lenticle dying out in the midst of Boulder Clay both above and below. It is in this earth that the flint implements have been found, which are thought by some to be of Glacial age. A long section is given, that was seen in 1877, between Thetford waterworks and the station, where the Chalk shows an undulating sloping surface, the lower slopes occupied by Boulder Clay, the upper part of which contains a trough of loam, which is repeated higher up lying directly on the Chalk. This Boulder Clay is supposed by Mr. Skertchly to have been *pushed* under the trough.

The Boulder Clay proper usually contains only small stones, which are mostly of chalk and flint, and also "from other formations." The greatest thickness is 50 ft. at Ingham. Mr. Bennett states that the Boulder Clay west of Bury St. Edmunds is of local origin coming from the N.W., while that to the east is of more distant origin coming from the N.E., but they were contemporaneous.

An account of the literature of Roslyn Hole, Ely, with its great boulder of chalk and gault, is then given, down to Mr. Skertchly's description in the "Geology of the Fenland," which is quoted at length. A little N. of Ely some boulders of gneissic granite, basalt and sandstone are found. Exposures of Boulder Clay are mentioned near Flempton, Hengrave, Fornham, Elvedon Warren, Brandon Park and Thetford Warren.

Some high level gravels, belonging to ancient river systems now altered, are found at slight (70 ft.) elevations from the south of Mildenhall to above Lakenheath. They often contain implements. Details are given between Landwade and Snailwell, at Warren Hill, east of Eriswell, at Lakenheath, and north of Long Stanton.

The other gravel patches in the district are referred to

the present rivers when they were at a higher level. Details are given at Kentford, where flint implements have recently been found, at Kennet Heath, at Thorney, Soham, Treckenham, Herringswell, Flempton, Hengrave, Fornham, between Icklingham and West Stow where at one place there is Boulder Clay above, considered to be redeposited; at Icklingham, Barnham, Thetford and Redhill—most of these have long been noted. Figures of flints from these gravels are given from Evans' "Ancient Stone Implements."

The description of that part of the Fens that falls within the district is taken from the "Memoir on the Fenland," by S. B. J. Skertchly.

***176. Hicks, H.—On Some Recently-Exposed Sections in the Glacial Deposits at Hendon.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 575, pl. xxii.

The map given in the plate shows that these deposits have a wide spread on the eastern side of the Midland Railway, covering, in fact, most of the ground, except close to the Brent and its tributaries. The upper part consists of chalky Boulder Clay, the chalk often decomposing into "race." This varies in position in different localities, from 285 ft. to 175 ft. above O.D., "proving conclusively that the Brent valley had been in the main scooped out previous to the deposition in it of the newer Glacial deposits."[1] Beneath this clay are—first a 6—12 in. band of laminated clay without stones, and then 6—8 ft. sand and gravel, sometimes false-bedded. The coarsest is at the base, and contains fragments of sarsen-stones, flint blocks, rolled flint pebbles, chert, ferruginous sandstone, quartz, quartzite, and ironstone. These deposits are often excavated in deep channels, sometimes down to the London Clay below, and these channels are filled with the overlying Boulder Clay. The gravels rest on a very uneven surface, indicating glacial erosion. It follows that these gravels belong to the so-called Middle Glacial Period, and as they are apparently continuous with those which yield implements in the Thames valley, man must have lived there in mid-, if not in pre-Glacial times.

***177. Hill, E.—On Wells in West Suffolk Boulder Clay.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 585.

The water in wells in the neighbourhood of Cockfield is met with at various depths—35 ft., 74 ft., 10 ft.—in the same grounds. At the Post Office no water was met with in 83 ft. All these are sunk in Boulder Clay. He concludes that there must be permeable seams in it which com-

[1] It has been suggested that the lower deposits may have been let down gradually as the denudation proceeded. *See* No. 185.

municate with the surface. Such a seam he has seen at Ballingdon Brickyard, Sudbury, where below 10 ft. of yellow clay comes a sandy streak, running horizontally, and then turning up till it reaches the surface. This is not what he would "expect in a mass resulting from the abrasion by a glacier of its bed."

***178. Monckton, H. W.—On the Boulder Clay in Essex.**

"The Essex Naturalist," vol. iv., p. 199.

According to certain diagrams, Boulder Clay does not rise to the summits of the hills in South Essex, but is confined to the valleys. The author, however, on testing this, has found that there is Boulder Clay 359 ft. above O.D., only 20 ft. below the highest point of Epping Ridge; at Ongar Park Wood, at 340 ft., and on the south of the ridge at Theydon Bois. There is also blue-grey clay on the Warley Plateau, thus showing that the ice did mount the hills as far as this.

179. French, J.—Boulder Clay in Essex.

"Essex Naturalist," vol. v., p. 133.

It having been argued by W. H. Dalton (p. 102) that the Boulder Clay above noticed [No. **178**] could not have been left by an ice-sheet, as the ground below is not disturbed, the author gives examples of non-disturbance between Braintree and Bulford stations, and at Blewitt's Pit, north-east of Stebbing village, where the junction with the Westleton beds below is very sharp. It is, however, less sharp where resting on Middle Glacial gravels.

***180. Monckton, H. W.—Notes on the Glacial Formation near Chelmsford.**

"Essex Naturalist," vol. v., p. 191.

There is no Lower Boulder Clay here. The lowest beds are gravel, consisting of—1. Flint pebbles; 2. Subangular flints; 3. Black flints; 4. Pebbles of quartz; 5. Pebbles of red and white quartzite; 6. Blocks of various old rocks; 7. Small pieces of chert. All except Nos. 5 and 6 may be local.

***181. Monckton, H. W.—Excursion to Chelmsford.**

Proc. Geol. Assoc., vol. xii., p. 202.

In several pits gravels are seen underlying Boulder Clay, the latter yielding a block of garnetiferous mica-schist. The presence of Triassic pebbles of quartzite in the former shows that they were not pre-Glacial.

182. French, J.—On the Occurrence of Westleton Beds in part of North-west Essex.

"Essex Naturalist," vol. v., p. 210.

In the district examined, between Braintree and Dunmow,

the Westleton beds are distinguished from the Middle Glacial gravels by the presence in the latter not so much of Triassic pebbles, as of crystalline rocks, as well as the abundance of quartz in the former. The sections where the Westleton beds may now be seen is then given, viz.: in the cutting between Bulford and Braintree, where 40—60ft. are capped immediately by Boulder Clay; in Hunnable's gravel pit, Braintree, where beds with implements are overlain by undisturbed Westleton shingle, which is, however, believed to have slipped down; on Clap-Bridge Farm; in the goods siding at Rayne; at Felstead Station; ¼ mile west of Dunmow Station; near Highwood where Middle Gravels are banked against a yellow micaceous sand, believed to belong to the Westleton series; in the sand pit at Stebbing Downs, where 4 ft. of Westleton gravel is underlain by 8 ft. of similar micaceous sand; at Brewitt's gravel pits 1 mile east of Bran End where 6 ft. of Westleton shingle is overlain directly by Boulder Clay; and just north of Saling Church where Boulder Clay, Middle gravel and Westleton shingle (12 ft.) are all present. **W. H. Dalton** notes also in an appendix two outliers of Westleton beds at Writtle Mill and Roxwell Hoe Street.

183. Spurrell, F. C. J.—Excursion to Grays Thurrock, Essex.

Proc. Geol. Assoc., vol. xii., p. 194.

Nothing new is here recorded.

***184. Holmes, T. V.—Excursion to the New Railway between Grays and Upminster, Essex.**

Proc. Geol. Assoc., vol. xii., p. 195.

A section is given from West Thurrock, across the Mardyke. Oblique pipes in the chalk, letting down the overlying gravel so as to look like an intercalated bed, were noticed; also the irregularity of the junction between the gravel and the Chalk and Lower Tertiaries, for which the aid of the action of river ice was suggested. Subsidences due to former chalk workings were also seen between Grays and Stifford.

***185. Monkton, H. W., and Herries, R. S.—On Some Hill Gravels North of the Thames.**

Proc. Geol. Assoc., vol. xii., p. 108.

Notices of sections are here given, which show gravels referable to one or other of the groups of pre-Glacial gravels lately established by Professor Prestwich [*see* No. **259**, 1890]. The authors state, in reference to the heights of these gravels above the valleys, that "in all cases there is a tendency on the part of the materials of which these gravels are composed to travel down to lower levels, and to form new gravels; then, as denudation proceeds, these new gravels

are, in their turn, apt to become the cappings of minor hills."[1] The places described are Billericay, at 319 ft. gravel, with quartz pebbles; Wotherspoons, 310 ft., considered post-Glacial by the Survey, with Lias quartz pebbles, and quartzite blocks; Coopersale Common 347 ft. *typical* "Westleton" beds; Newhouse 350 ft., quartz pebble bed overlain by probable Boulder Clay; Bell Bar 360 ft., numerous quartz pebbles and unworn flints; Chipping Barnet 400 ft., the best exposure near London, stratified sands and gravels, the former lenticular—order of abundance of pebbles, flint, quartz, quartzite, subangular flints, chert; Bentley Priory—the beds here described by Professor Prestwich they consider "Westleton," as there are few subangular flints and many quartz pebbles; Nettlebed 650 ft., with sand, which belongs to the same series; Greenmore Hill, a variety of the Westleton; and Bowsey Hill, Twyford, full of white quartz pebbles.

***186. Monckton, H. W., and Herries, R. S.—Excursion to the Bagshot Country between Aldershot and Brookwood.**

Proc. Geol. Assoc., vol. xi., No. 9, p. 154.

A gravel with subangular chalk flints, on Fox Hills, and near Mitchet Lake, are considered to be old river gravels.

187. Blake, J. H.—Excursion to Henley-on-Thames and Nettlebed.

Proc. Geol. Assoc., vol. xii., p. 204.

At the latter place the presence of quartz-bearing pebble gravels referred to the "Westleton beds" was verified.

***188. Prestwich, J.—On the Age, Formation, and Successive Drift-stages of the Valley of the Darent; with Remarks on the Palæolithic Implements of the District, and on the Origin of its Chalk Escarpment.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 126, pls. vi.—viii.

The oldest superficial deposit is the Chalk Plateau Drift on the Red Clay. It is earlier than the existing valleys, since it is met with on the opposite side capping Tertiary strata at Swanscombe. If the valleys are of Glacial origin, this must be pre- or very early Glacial. On either side of Darent Valley, this drift caps the highest summit levels of the chalk escarpment up to 864 ft. Besides brown flints, it contains some Lower Greensand chert and ragstone. Associated with this drift, flint implements, spoken of as the "Ash type," have been found. These are very rude and have been much rubbed. Similar ones have been found on the Chalk ridge

[1] One ought to be able to distinguish such slipped gravels from original gravels if they show any bedding.

near Eastbourne. [For details of these implements, *see* No. **291.**]

The initial stages of the Darent valley are indicated by a gravel full of Lower Greensand *débris*, on the hill west of Eynsford, at 280—360 ft. above O.D., *i.e.*, 180 ft. or more above the river, and possibly by flint drifts at 600 ft. and 530 ft. nearer the escarpment. Also by a compacted chalk breccia 200 ft. above the present stream, at Meenfold Hill, Shoreham, which indicates a former spring at this level, when it was the base of the valley.

The High Level or Limpsfield gravel stage is first indicated by a bed of gravel on the watershed at Limpsfield Common. This is 200—300 ft. below the neighbouring heights, and was therefore formed after much denudation. The contents are almost all flints and Tertiary pebbles, and implements of St. Acheul type have been found. Similar gravel caps Farly Hill 51 ft. lower, giving a gradient of 25 ft. per mile; also at Brasted Park and Sundridge 68 ft. lower, giving a 22⅝ ft. gradient; these contain more Lower Greensand pebbles. Next comes Broughton Hill 53 ft. lower, giving 21½ ft. per mile. There are also patches lower down the valley, at Eynsford and Farningham 137 ft. lower, giving 25 ft. per mile. From this to Dartford gravel is a fall of 22 ft. per mile. As this last belongs to the Thames system and contains Triassic quartzite pebbles, the whole series must be post-Glacial, or equal in age to the "Upper Terrace of High-level Thames Gravel." The gradients show a remarkable agreement, and indicate an older and wider floor out of which the present valley channel has been excavated. The Limpsfield implements agree generally with the "Hill group." Similar forms have been found in drifts in analogous positions in the valley of the Cray.

There is a brick-earth at Limpsfield 10—30 ft. lower than the gravel, with more chert, ragstone, and ironstone scattered irregularly through the earth, which has an indented surface, perhaps caused by ice.

The Dunton Green drift is 87 ft. below that of the neighbouring Broughton Hill, and differs from it in having more angular flints, fewer Tertiary pebbles and brown flints, and no stratification. A cutting between Combe bank and Chevening shows an undulating surface of Gault, with the gravel lying in pockets and troughs, as though pushed into the clay. Its contents are flints from the Red Clay and Tertiary pebbles, but no Lower Greensand pebbles, it has come, therefore, from the escarpment above. The phenomena at these three last places point to a return of glacial conditions. This is confirmed by the flatness of the re-formed gault-cover at Chevening, by the pitted condition of some of the flints,

and by the occurrence of some displaced blocks. But he concludes by stating that he suspects an additional agency now.

The Low Level valley gravels occur at several spots, of which that at Otford Brickyard is described as with 60 per cent. of Lower Greensand pebbles; this is connected with a bed 30 ft. above the river at Eynsford, and with a talus-like mass in a cutting a quarter of a mile west of Dartford, which corresponds to the mammaliferous bed at Erith. This group is said generally to contain implements, but it is not stated where. In the Dartford cutting, the Chalk, except where the gravel occurs, is curiously festooned. This festooning took place, therefore, before the undermining of the chalk and deposit of the gravel, and may be an indication of earlier-occurring glacial conditions.

The slopes of the chalk hills often have masses of chalk and flint rubble, sometimes covered by red loam, and containing materials foreign to the spot. The former he regards as due to the same glacial conditions.

Finally he discusses the theory of the subaerial denudation of the Weald, and objects that if the escarpments were due to this cause, the valleys below them should contain the flints from the Chalk and Red Clay, and some Tertiary pebbles, at least within the area to which the Chalk, after marine denudation, originally extended—4 miles south according to Ramsey, but more probably 31 according to the author. He admits that such ingredients do occur in the gravel described, "though in very small quantity, and only in local patches," but objects that they do not possess the uniformity and special local character they ought. The subaerial theory being considered untenable, he propounds the view that "glacial agency was the great motor in developing the valleys, and as a consequence the escarpment," but does not directly develop this any further than by calling this and "strong river action" "more energetic agencies."[1]

189. Reid, J.—A Short Account of some Bones and Teeth found in the Valley Drift of the River Stour, near Canterbury.

"The South-Eastern Naturalist," vol. i., p. 51.

The deep deposit which has long been worked behind the south side of Wincheap Street, has been opened into recently in the "Martyrs' Field," and a cervical vertebra and portion of teeth of the Mammoth, a molar tooth of

[1] The main question appears to be whether the rivers have sufficien power to remove the harder as well as the softer materials. There will be little difficulty in answering this in the affirmative for those who know what a clean sweep the rivers have made of pebble beds and conglomerates in some valleys, leaving little if any gravel of the extracted pebbles.

Rhinoceros tichorhinus and metacarpal of horse have been obtained.

190. Bell, A.—Notes on some Post-Tertiary Marine Deposits on the South Coast of England.

Proc. Geol. Soc., p. 172.

The short abstract gives but few of the facts. In Bracklesham Bay there is (1) an estuarine clay, (2) compact hard mud, (3) fine sandy silt [ascending or descending ?]. Of the fauna 17 per cent. are southern and 45 per cent. are found in the Crags.

***191. Hicks, H.—On the Evidences of Glacial Action in Pembrokeshire and the Direction of the Iceflow.**

Geol. Mag., Dec. 3, vol. viii., p. 500. Abstract of Paper read at the Brit. Assoc., Aug., 1891.

These evidences are excellent sections of unstratified drift in Whitesand Bay, with several feet of irregularly stratified sand below, lying on a striated surface, the striæ pointing from N.W. There are also numerous perched blocks, the majority of which are of the local igneous rocks forming the hills along the north coast of the county; but there are also flints from Ireland and a boulder of picrite and another of porphyritic granite which may be matched in Anglesey.

192. Worth, R. N.—Occurrence of Layers of Carbonised Wood in a Limestone Fissure at Pomphlett.

In Sixteenth Report of the Committee of Scientific Memoranda, Rep. and Trans. Devonshire Assoc., vol. xxiii., p. 112.

The fissure is a deep one in Plymouth limestone and at about 66 ft. from the top is a horizontal layer of black carbonised wood in the midst of red clay. Amongst this occurred leaves of *Betula nana* indicating a colder climate than that of the neighbourhood at present.

***193.—Bell, D.—On a Glacial Mound in Glen Fruin, Dumbartonshire.**

Geol. Mag., Dec. 3, vol. viii., p. 415.

Glen Fruin is a glen six miles long between Gareloch and Loch Lomond, descending in a S.E. direction; at its base is found a large block of mica-schist lying on calciferous sandstone, which has been thought to have been left by an iceberg during the "great submergence." This paper brings forward evidence against the occurrence of any such submergence. A little further up the glen is a transverse "terminal moraine" of a well-marked mound, or embankment-like character, of unstratified local material, some 10—25 ft. high; smaller mounds, relics of older glaciers, occur lower down. Now there

could have been no submergence since this moraine was formed, or it would have been washed down, nor during its formation, for it would have been horizontal; but it is not, for it climbs the sides of the glen, and it is unstratified. Nor, as it would probably be contended, was there a prior submergence, for in that case the sea would have gone into the crannies of the land, and the deposits left could not be carried away by the glacier, which sweeps the main valley only; and if they had been, their relics, with marine shells, should be found in the *débris* at the base of the valley, as is always the case where glaciers are known to have swept over previously submerged areas. Here, therefore, at least, there is no proof, but rather the reverse, of any "great submergence."

193a. Blair, M.—The Surface Geology of Paisley

Trans. Geol. Soc. Glasgow, vol. ix., pt. i., p. 139.

Gives details at various points in the town. The surface of the solid rock varies much in depth below the surface, there being buried valleys and escarpments. There are two Boulder Clays, the upper one being much more tenacious. At the harbour on the river Cart there is a fine laminated clay following the uneven surface of the Boulder Clay, with sand filling up the hollows, both unfossiliferous, and above these is a shelly sand. The highest point to which submergence is here proved is 73 ft.

194. Smith, J.—The Great Ice Age in the Garnock Valley.

Trans. Geol. Soc. Glasgow, vol. ix., part i., p. 151, pls. vi.—xi.

A long and detailed list is first given of all the boulders noticed in the Garnock river and its tributaries in the North of Ayrshire. Two of these, 28 ft. below sea level in a sinking, are covered with barnacles, &c., and indicate transport by icebergs; the rest he refers to land-ice. The local boulders are numerous, except in the extreme west, and indicate a N.E. source. Foreign boulders come from the neighbourhood of Loch Lomond and Ben Cruachan, which lie in a N.W. direction. Nevertheless there are very few on the west side, while on the east they are comparatively numerous. These must also have come round by the N.E., whence all the striæ point. Some of the Highland ice was forced *up* the Clyde valley, and then deflected south-west by the Clydesdale ice. That they were brought by ground ice is shown by the "friction quarrying" of the underlying rocks. The striæ in the V-shaped valleys run with the glen, and those on the moors in a different direction. He concludes that the lower part of the ice moved down the valleys, while the upper moved across them; the foreign boulders sometimes sinking through the ice into the lower part so as to fall in the

valley. He mentions also *roches moutonnées* forming hills up to 1,660 ft.[1]

In the lower part of the valley the Boulder Clay ridges are cut up into "drums" by a later glaciation or by the sea. The Boulder Clay contains everywhere the greatest abundance of the rocks over which it has just passed, so that those taken up earlier must have been ground to mud, and those which have travelled furthest are always the smallest, in proportion to their hardness. The average thickness is about 10 ft., with a maximum of 70 ft. There is an almost entire absence of lateral moraines in the Garnock valley, only one, 90 yds. long, being noticed, and this he explains by the ice melting *in situ*. Some contorted drifts at Kilwinning Station he explains by the grounding of an iceberg. The absence of boulders on Craigmaddie Moor is accounted for by the grinding-up action of the coarse grit of which it is composed, which has reduced them all to mud, and this mud would be washed away.

***195. Millar, W. J.—Notes on the Excursion to the New Reservoir for Bowling Water-Supply on 23rd March, 1889.**

Trans. Geol. Soc. Glasgow, vol. ix., pt. i., p. 203.

When the Boulder Clay was cleared off one side of the valley, some fresh glaciated surfaces of trap rock were exposed, the striæ facing from the north and north-west.

***196. Bennie, J.—On things New and Old from the ancient Lake of Cowdenglen, Renfrewshire.**

Trans. Geol. Soc. Glasgow, vol. ix., pt. i., p. 213.

Many years ago a bed of clay and peaty mud, "the remains of a long-buried Lochlibo," were found in a cutting in Cowdenglen between two Boulder Clays, and old discussions have ended in the belief that the deposit is interglacial. The plants found were named by C. Reid in 1888, and a list is here given. Since then the gemmules of freshwater sponges —*Spongilla lacustris* and *Meyenia fluviatilis*, statoblasts of *Cristatella mucedo*, some remains of recent Coleoptera, and some mosses have been found. They all appear to belong to species living in the country at the present time.

197. Bell, A.—Fourth and Final Report of the Committee . . . appointed for the purpose of reporting upon the "Manure Gravels" of Wexford.

Rep. Brit. Assoc. for 1890, p. 410.

The main object of this is to give complete lists from published, or new sources, of the species of Mollusca found in various superficial deposits along the east coast of Ireland.

[1] The "crag," however, is figured as on the N.E., and the "tail" on the S.W.

These are—(1) Wexford Manure Gravels; (2) Ballybrack Gravels; (3) Gravels near Dublin; (4) Gravels and Raised Beaches in Balbriggan Bay; (5) Boulder Clay of North-east Ireland; (6) Ballyrudder Clay; (7) The Turbot Bank, co. Antrim; (8) The Estuarine Clays of North-east Ireland; (9) Raised Beaches of co. Antrim and co. Down; (10) The Sands of Portrush. The last three contain recent species only. The locally extinct species in the other places are given in the following list:—

Habitat unknown.
- Fusus menapii (1).
- Melampus pyramidalis (1).
- Nassa granulata (2).
- ——— reticosa (1).
- Pleurotoma lævis (1).
- Nucula Cobboldiæ (1).

South European.
- Cypræa sp. (1).
- Fusus rostratus (1).
- Mitra? sp. (1).
- Nassa semistriata (1).
- Turritella incrassata (1).
- Leda pusio (1).
- Pecten glaber (2).
- Woodia digitata (2).
- Pectunculus pilosus (1).

Boreal.
- Acirsa borealis (7).
- Buccinum cyaneum (7).
- ——— greenlandicum (6).
- Cerithiopsis costulata (7).
- Columbella Holbōllii (4), (7).
- Fusus islandicus (1).
- Fusus Sabinii (1).
- Margarita cinerea (7).
- Meyeria pusilla (1).
- Molleria costulata (7).
- ——— greenlandica (7).
- Natica affinis (1), (5), (6), (7).
- Pleurotoma decussata (6).
- ——— exarata (1), (6).
- ——— harpularia (1).
- ——— nobilis (1).
- ——— pyramidalis (1), (2), (6).
- Purpura incrassata (1).
- Scalaria greenlandica (1).
- Trophon clathratus (1), (5), (6), (7).
- ——— craticulatus (1).
- ——— latericeus (1), (5).
- Turritella erosa (6).
- Astarte borealis (1), (2), (3), (4), (5).
- Leda abyssicola (4).
- —— arctica (4).
- —— buccata (2).
- —— pernula (1), (2), (3), (4), (5), (6).
- Nucula proxima (1).
- Tellina calcarea (2), (4), (5), (6).
- Yoldia hyperborea (1).
- Rhynchonella psittacea (6).

He speculates on the source of these shells. The extinct and Mediterranean probably came from the south by way of St. Erth, the more boreal by a channel nearest the Irish coast, either *viâ* the Caledonian Canal or the Firth of Clyde, at a time of greater depression than at present.

198. Cruise, R. J.; McHenry, A., &c.—Explanatory Memoir to accompany Sheets 3, &c. Chaps. XI., XII., XV. [*See* No. **71.**]

Mem. Geol. Surv. Ireland.

The glacial deposits in N.W. Donegal are chiefly Boulder Clay, sometimes 40 ft. thick, arranged in ridges, with ice-scratched boulders from the east and north-east. The ice-scratches go to a height of 1,400 ft. on Scraig's mountain quartzite, and the Muckish range is smoothed up to 1,300 ft. Along the borders of the Ray a great gravel terrace extends for two miles from the sea. Moraines are seen along the southern side of Gweedore Valley. In this district two sets of striæ cross, one W. 15° N., belonging to the Scotch Ice-

flow, the other N. 40° W. up to 800 ft., and others W. up to 1,800 ft. on Agla, belonging to southern ice. On Bloody Foreland is a boulder of granite 15×12×9 ft., and the Boulder Clay is 40 ft. deep. It reaches a height of 1,000 ft., and at the foot of the hill a line of blocks marks the northern limit of the ice-sheet. Peat deposits are widely spread over the drift, and are found below the sea, indicating a recent submergence. Blown sands also accumulate here, and villages have been buried by it. An old sea cliff at Ballymastocker Bay is 1,000 ft. inland.[1]

A list of 272 ice-scratches is given, of these 88 are within 10° of N., and 79 more are within 30° of N.

***199. Kilroe, J. R.—Explanatory Memoir to accompany the Maps of South-West Donegal. Chap. VIII. Post Pliocene (Drift Deposits).** [*See* No. **71a.**]

Mem. Geol. Surv. Ireland.

The Boulder Clay occurs in drumlins and contains local *débris*. Striæ occur at 1,940 ft. and 1,000 ft. on Aghla and Slieve League, and lateral moraines are observed in Finn Valley with the terminal moraine at the west end of the Lough. Crolevy Lough has been formed by a moraine in Slieve League corry.

In Table B, ice-scratches in 48 localities are recorded, in 28 different directions, all within N. 20° W. and S. 5° W.

200. Symes, R. G.—Explanatory Memoir to accompany Sheets 31, &c. Chap. VII. [*See* No. **71.**]

Geol. Survey of Ireland.

The Drift about the Ballyshannon district is all Boulder Clay, and sometimes very thick. The boulders are all of local rocks, and vary according to the underlying materials, apparently not shifted far, but the direction in which they must have been moved is not discussed. There are some large granite erratics brought down from Barnesmore Mountain, 10 miles to the north, others of gneiss and dolerite.

Twenty-eight glacial striæ are recorded, of which 11 are E. and W., 4 are W. 10° N., 1 is W. 20° N., 1 is W. 10° S., 2 are W. 15° S., 2 are W. 20° S., 1 is W. 40° S., 1 is W. 25° N., 1 is W. 25° S., 2 are N.E., 1 is N. 40° W., and 1 is N. 37° E.

BOULDERS.

***201. Crosskey, H. W.—Eighteenth Report of the Committee Appointed . . . for the purpose of Recording the Position, Height above the Sea, Lithological Characters, Size, and Origin of the Erratic**

[1] This would seem to show elevation of an earlier date.

Blocks of England, Wales and Ireland, Reporting other Matters of Interest connected with the same, and taking measures for their Preservation.

Report of the British Association for 1890, p. 340. [Boulders more than 10 cub. ft. are marked L., others S.; the "feet" are "above the sea level."]

The following are recorded: *Warwickshire*, Sherbourn, 1 S. Millstone Grit, 1 L. granite; Exhall, 1 quartzose; *Lancashire* and *Cheshire*, Fallowfield, 1 S., Buttermere syenite 1 S., andesite, both 115 ft.; Old Trafford 1 L., Coal-measure Sandstone; Taxal, 1 L.; Eskdale granite and 1 L. Buttermere syenite, 1 L. Borrowdale andesite, all 1,150 ft. None of the boulders in this district are ever found either N. or. W. of the parent rock, and those which have been torn off at the base of the drift from neighbouring rocks, *e.g.*, Ardwick Limestone at Slade Lane, have moved easterly. No Manx or Irish rock has been found in Lancashire. At Rawtenstall are 2 of Borrowdale ash, 7 Borrowdale lava, 2 Borrowdale amygdaloidal andesite, 2 undetermined volcanic, 2 Buttermere syenite, 5 undetermined granite, 1 Criffel granite, 2 Loch Doon granite, 10 Eskdale granite, 1 Rig o' Barnfoot granite, 1 Muscovite granite, 5 vein quartz, 1 ditto with ochreous sandstone, 1 Mountain Limestone chert, 3 Mountain Limestone, 2 Red Sandstone, 1 Hæmatite. At Wardle, 1 L., Rushy Hill Sandstone 600 ft.; Spotland, a group of Lake District rocks and Criffel granite, 800 ft. At Werneth Low 800 ft., 2 Eskdale granite, 1 Buttermere syenite, 7 Borrowdale andesite, 3 Borrowdale agglomerate, 1 Borrowdale rhyolite, 1 Borrowdale porphyrite, 5 Silurian grit, 2 Coal-measure sandstone, 1 quartzite, 1 Bunter pebble. *Derbyshire*, in the valley on either side of the Windgather rocks are numerous Lake District rocks rising nearly to the summit, with them are Eskdale granite, Bunter pebble, and Wrekin quartzite? *Yorkshire*, numerous boulders in the district studied by G. W. Lamplugh, *see* No. **202.** Also at Kilnsea, 1 L., Shap Fell granite (its furthest known extension).

*202. **Lamplugh, G. W.—On the Boulders and Glaciated Rock-Surfaces of the Yorkshire Coast.**

Rep. Brit. Assoc. for 1890, p. 797.

This gives a comparative table of the different kinds of material of the boulders over 1 ft. in diameter in the following districts:—1. South Holderness; 2. North Holderness; 3. Flamborough Head; 4. Filey; 5. Cayton Bay; 6. Robin Hood's Bay; 7. Whitby. These are, per cent.:—

Carboniferous Limestone	22·8	17	23·3	13	14	13	30
Palæozoic sandstones and grits	14·4	45	26·8	15	25	28	18
Mesozoic rocks ..	22·1	22	1	51	40	48	35·5
Eruptive rocks ..	37·3	14	43·2	19	18	7	15·5
Granite, gneiss, &c. ..	3·4	2	5·7	2	3	4	1

These proportions confirm his view of the deposits having been brought by glaciers passing over the North Sea, and deflecting others that came eastwards down the valleys of the Tees, &c. He has found also a glaciated surface on the Corallian at Filey Bay, the striæ running N. 20° E.

***203. Lamplugh, G. W.—On the Larger Boulders of Flamborough Head and other parts of the Yorkshire Coast. Part iv.**

Proc. Yorkshire Geol. and Polyt. Soc., vol. xi., pt. iii., p. 397.

This is the same paper that is published by the British Association in abstract, but more detailed tables are here given of the percentages of the various kinds of rock between South Sea Landing and Flamborough Head, at Hornsea, Filey, Cayton, Robin Hood's Bay, and Whitby. The table given in No. **202** is a summary of all these and previous tables. In an appendix a list of various particular boulders is given.

***204. Harrison, S. N.— Boulders around the Maughold Coast.**

"Yn Lioar Manninagh," vol. i., p. 288.

These are subangular or rounded, and are referable to five types of granite, viz., the Aberdeen, Criffel, Newry, Kirkcudbright, Loch Aire, and Red Granite—83 in all are noted. There are also noted 2 of Trap, 2 of Syenite, 1 of Pitchstone, 1 of Basalt, 1 of Porphyry, 1 of Red Sandstone. The granites are all foreign to the island.

205. Kendall, P. F.—On the Source of Some Remarkable Boulders in the Isle of Man.

Mem. and Proc. Manchester Lit. and Phil. Soc., vol. iv., p. 217.

Several boulders of a fine-grained granite containing riebeckite from the Isle of Man, and one from Moel Tryfaen, resemble in character the riebeckite rock of Ailsa Crag rather than that of Mynydd Mawr. Their occurrence confirms the conclusions arrived at by the striæ that ice came out of the Firth of Clyde into the Irish Sea, and must have risen 250 ft. between Ailsa Crag and Moel Tryfaen.

***206. Reade, T. M.—The Perched Blocks of Norber Brow and their Levels relative to their Place of Origin.**

Geol. Mag., Dec. 3, vol. viii., p. 291.

These blocks are masses of Silurian slate lying on pedestals of Carboniferous Limestone, whither they were brought in the last phase of the Glacial Period. T. McK. Hughes, in his description of these (Q.J.G.S., vol. xlii., p. 531), considered that they had been pushed up from a lower level, as the ice-sheet surmounted a barrier. The author and others

accordingly sought the highest spots at which such slates occur in the neighbourhood, and taking the block figured by T. McK. Hughes as a datum level, they found loosened blocks of the Silurian ready to be transported at a height of 265 ft., and other masses at 295 ft. above it. Hence they could be brought by a glacier filling Crummack Valley, and moving southward and downhill.

***207. Reade, T. M.—Notes on a Section of the Trias and Boulder Clay in Chapel Street, Liverpool.**

Proc. Liverpool Geol. Soc., vol. vi., p. 316.

Six boulders of decomposed greenstone of small size and one of Silurian grit were seen adhering to the surface of the Trias sandstone, into which they appear to have sunk—or the sandstone may have been broken up and rehardened. Stratified sand is associated with them, and there are no glacial striæ on the rocks. This Boulder Clay belongs to the Low Level group, and the boulders are most easily accounted for by their having been dropped by floating ice on a shelving shore. The evidences of aqueous agency seem to the author a great argument against the theory of an ice-sheet.

***208. Reade, T. M.—A Further Note on the Decomposed Boulder and Underlying Red Sandstone in the Chapel Street Section, Liverpool.**

Proc. Liverpool Geol. Soc., vol. vi., p. 333.

Between the boulder and the main rock there is an indurated shell of sandstone, containing minute specks of the greenstone and cemented by secondary silica. This shows that the boulder has not been forced into the solid rock, but that its bed was soft when it was deposited.

209. Antrobus, J. C., and Hatch, F. H.—Preliminary Note on the Composition and Origin of Cheshire Boulders.

Rep. Brit. Assoc. for 1890, p. 813.

Sixty-eight boulders from the neighbourhood of Eaton, near Congleton, have been examined microscopically; 26 of these were granites, microgranites and granophyres, four being Muncaster granite, and five Buttermere granite (but no Shap), the rest being probably Scotch; 28 were volcanic from Borrowdale, eight being andesite, seven rhyolite, and the remainder tuff. There were also a gabbro and a basalt like those of the Western Isles. Nine were quartzites of the Ganister Beds, and the rest were undetermined.

210. Bolton, H.—Note on Boulders at Darley, near Matlock, Derbyshire.

Geol. Mag., Dec 3, vol. viii., p. 512. Abstract of paper read at the Brit. Assoc. in Aug., 1891.

A cluster of 15 blocks from the grit of the adjoining hills in bed of "Boulder Clay," thought to be redeposited.[1]

***211. Woodward, H. B.—Note on a Greywether at Bayswater.**

Geol. Mag., Dec. 3, vol. viii., p. 119.

This is a block 9 ft. 6 in. × 9 ft. 6 in. × 2 ft. 8 in. lying in the Thames valley gravel, on the London Clay, at the King's Head cellar, Moscow Road. It may have come out of the Drift, or have been derived directly from a Bagshot outlier, or be a relic of pre-Glacial denudation of the neighbourhood.

GLACIAL THEORIES.

212. Ball, Sir R. S.—The Cause of an Ice Age.

London: Kegan Paul, Trench & Co., 8vo, pp. 180.

This book commences with a graphic account of the well-known glacial phenomena, which have to be explained, amongst which is included a great polar ice-cap covering the greater part of the British Isles to a depth of hundreds or thousands of feet: he considers also that there are evidences of alternations of genial and glacial periods. Alterations of land configuration are not sufficient to account for phenomena on so grand a scale—but to an astronomer an Ice Age is only a trifling incident. If we put the temperature of the earth, unheated by the sun, at a low enough point, a small percentage variation of the sun's heat will make a great difference in temperature.

There is no substantial ground for believing the sun to be a variable star; nor can variations of the heat of space due to the stars be possibly of any great amount. Under the attraction of the planets, however, the orbit of the earth is variable to a slight extent, particularly in its eccentricity; an increase of eccentricity diminishes the minor axis, and the total quantity of heat received during a revolution is inversely proportional to the minor axis—but the change from this cause is very slight. The distribution, however, of heat during the seasons depends upon the position of the line of equinoxes—since "the total heat received by the earth from equinox to equinox while moving round one part of its orbit is equal to that received by our globe while completing its journey round the remaining part." If, therefore, the line of equinoxes divides the orbit unequally, one hemisphere will have extreme summers and winters and the other more uniform seasons, yet "the total quantity of heat which each receives would be absolutely the same;" but "that the heat received during

[1] Can these possibly have been pitched there?

summer is equal to that received during winter is not true." In place of this he "enunciates a fundamental truth." "*Of the total amount of heat received from the sun on a hemisphere of the earth in the course of a year,* 63 *per cent. is received during the summer, and* 37 *per cent. is received during the winter.*" (Italics.) This "announcement is the novelty in this book—the one central feature by which it is to be judged." This will be just as much the case if the seasons be unequally divided, as "the increased proximity to the source of heat compensates for the brevity of the season." The numbers here given depend upon an entirely distinct element, namely—the obliquity of the ecliptic.

When the line of equinoxes is perpendicular to the major axis of the ellipse, the difference in the length of the seasons will be 465 times the eccentricity; with the present eccentricity this would be 7 days with the maximum 33. The two causes conspiring make the maximum difference in the seasons—supposed to correspond to a glacial epoch. Under these circumstances the mean daily heat in summer in the Northern Hemisphere would be to the mean daily heat in winter as 1·38 : ·68. At present the corresponding ratio is 1·24 : ·75. Thus in a glacial period the summer heat would be 14 per cent. greater than at present, and the winter heat 7 per cent. less. If this percentage is taken on 300°, the supposed elevation of temperature due to the sun, the winter would be 21° colder than at present.

The author then gives an account of how he came to write this book. It was when he had worked out what he calls above the "fundamental truth," that he was astonished to find that it appeared unknown, and that even Sir John Herschel had enunciated an erroneous statement in its place when he said that extremes of climate would be "caused by concentrating *half* the annual supply of heat into a summer of very short duration, and spreading *the other half* over a long and dreary winter." He says, "it thus appears that the accurate law of the distribution of heat had escaped the attention of Herschel," and that other writers have followed suit. The law he now enunciates shows that, in spite of all modifying influences, the range of average temperature in the British Isles would have been 28° in a glacial period instead of 14° as at present. According to the other statement, "there would be only the inequality in the lengths of the seasons to be taken into account," making the ratio of mean daily heat in summer to that in winter 1·10 to ·92—a difference of ·18 instead of ·70 of a unit of sun's heat.

In corroboration of the astronomical theory, he cites the Alpine plants, which must have migrated to their present habitats during a glacial epoch, when the intervening low-

lands were at a suitable temperature, which also enabled the plants of the Northern Hemisphere to migrate to Patagonia. With regard to the numerous ice ages which must have occurred in the past, they will have appeared in groups, each member of a group being separated by about 21,000 years, and each group by a much longer period; but they would not all be of the same intensity. Genial periods must have intervened at the half intervals of 10,500 years, and "there must have been a species of rhythm in the manufacture of the stratified rocks corresponding to the rhythm with which the glacial periods and genial periods succeed each other." He "makes no attempt to harmonise the successive beds" of a formation "with recurrent ice ages"; "but that the recurrent ice ages are in some manner connected with this primary geological fact it seems hardly possible to doubt."

In the appendix, the mathematical calculations are given. The summer heat received in the Northern Hemisphere on a given area may be represented by $\frac{H}{r^2}(1 + \sin\delta)\,dt$ [by integrating $\frac{H\cos(\lambda-\delta)}{r^2}\,d\lambda$ along a meridian from $\lambda = 0$ to $\lambda = \delta + \frac{\pi}{2}$ where $\delta =$ sun's declination and $\lambda =$ latitude] also $r^2\,d\,\theta = h\,dt$, and $\sin\delta = \sin\theta\sin\epsilon$, where $\theta =$ R.A. and $\epsilon =$ obliquity. Hence, integrating from the vernal to the autumnal equinox, the total heat received $= \frac{H}{h}(\pi + 2\sin\epsilon)$ and similarly for winter. Hence the ratio of total summer heat to total winter heat $= \frac{\pi + 2\sin\epsilon}{\pi - 2\sin\epsilon}$ which with $\epsilon = 23^\circ\,27' = \frac{627}{373}$. The maximum difference in the length of the seasons, when the line of equinoxes is perpendicular to the major axis $= 465\,e$ days $[= \frac{4\,\epsilon}{\pi} \times 365$ if e is small] where $e =$ eccentricity, and putting e at its maximum value $= 0{\cdot}0745$, this gives 33 days.[1]

[1] The name of the writer of this book is sufficient to ensure great attention to what he says—but when to follow him involves the imputation of a fundamental error to Herschel, and of gross ignorance to all other writers on the subject, we must pause. If the words of Sir John Herschel had the meaning the author assigns to them, they would lead to the conclusion that the author draws from them—and arithmetically works out, so that there can be no mistake—that the only difference between summer and winter temperature is that due to the concentration of equal quantities of heat into unequal periods of time; but it would have this further result, that in the other hemisphere, which has a long summer and short winter, the summer would actually be the

***213. Ricketts, C.—Some Phenomena which occurred during the Glacial Epoch.**

Proc. Liv. Geol Soc., vol. vi., p. 225.

He considers a Polar ice-cap impossible to be formed, as the moisture-bearing air would be dried before reaching the Arctic circle, if the climate of Britain were glacial, and instances Siberia at the present time having an open coast-line. Against the notion that there has been a glacier pushing across Anglesey, or across Ireland, he quotes the fact that flints, which could only come from Ireland, have been found in Boulder Clay in Cheshire, which would be impossible if ice intervened.[1]

The Boulder Clay and its boulders have both been ascribed to icebergs, but this is improbable on account of the local character of some of the stones. He attributes the clay to sub-glacial rivers. The sub-glacial sands and gravels are derived from local rivers when the glacier filled the valley. The foreign boulders alone, including the flints, have been dropped by icebergs. The split and weathered boulders have lain in a moraine before transport, and have there been exposed to the variations of weather. When the pebbles are bored by molluscs they must have been carried about by shore ice. The effect of the deflection of the

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colder. We cannot possibly suppose that Herschel and his followers could not perceive this result. It is perfectly clear that the "heat" spoken of by Herschel is the "*supply*" *from the sun*, and is supposed throughout to be received on an equal area equally inclined to the rays. The phenomena of summer and winter depend, of course, on something else altogether, namely, the obliquity of the surface to the sun's rays. If θ_1, θ_2, be the local meridian obliquities, n_1, n_2, the numbers of days; h_1, h_2, the total "heat" in the above sense in summer and winter respectively in either hemisphere; then the meridian heat *secured* by that hemisphere on any one day may be roughly stated as proportional to $\int \frac{h_1 \cos \theta_1}{n_1} d\theta$ in summer and $\int \frac{h_2 \cos \theta_2}{n_2} d\theta$ in winter; and what Herschel says is *not* that $\int h_1 \cos \theta_1 \, d\theta = \int h_2 \cos \theta_2 \, d\theta$, which would correspond to the numbers 63 and 37, but that $h_1 = h_2$.

But, besides this, the meridian heat integrated along the meridian as is done by the author, will not give the total heat, which depends also on the length of the day at the various times and places. The total heat received at any latitude is completely worked out by Haughton (Trans. Roy. Irish Ac., vol. xxviii.), and the integration of his expressions, which are discontinuous at the Arctic circle, can alone give the total heat secured, a matter after all of little consequence, as it will include the tropics, which do not enter the question. The numbers 63 and 37 have, therefore, no significance whatever. The notion that the beds of a rock formation have any relation of any kind to Glacial Periods will seem absurd to every field geologist.

[1] They might be carried into the Irish Sea in pre-Glacial times.

Gulf Stream by the submergence of the Isthmus of Panama in causing a Glacial Epoch is then discussed.

***214. Bell, D.—Phenomena of the Glacial Epoch: II. The "Great Submergence."**

Trans. Geol. Soc. Glasgow, vol. ix., part i., p. 100.

The author argues against the theory of a submergence of more than 400—500 ft. There are no marks of old coast lines at heights of 1,000 ft. or more. Erratics and striæ may be equally due to land ice as to floating ice. Shell-less drift is known in Switzerland to be due to old glaciers and not to submergence. Shelly sands occur in Scotland at 510 ft. at Chapelhall, near Airdrie, but they are doubtfully *in situ*,[1] otherwise the highest is 350 ft., in Banff. Neither in England, Ireland, North America nor Norway is any submergence greater than 500—600 ft. anywhere generally indicated. It is, therefore, solely on the evidence at Moel Tryfaen, Macclesfield, and the Wicklow Mountains[2] that the belief in any greater submergence depends. What is the reason, he asks, for this restriction? If all the rest of the deposits which must have been formed have been removed by later glaciaton, this must have been "general" and not "local"; nor can glaciers do the work, for they produce "striated pavements" on Boulder Clay and do not remove it. Again, the sea goes into side valleys and nooks, and the glaciers go straight.[3] The sea makes shore-deposits at the same horizontal level, and the glacier goes on an inclined surface, and would only *cross* that level. Nor could the deposits be removed by ordinary denudation, which has not obliterated the parallel roads of Glen Roy. He accepts Jamieson's explanation of the valley terraces of so-called "marine drift" eroded by a later glacier, that they are lateral moraines. The shells at Moel Tryfaen, are mixed as to their depth and habitat, and must have been transported, along with the Northern Boulders; by what means "is a question of probabilities, whether the deposition of this shelly gravel was the work of land ice, whose work elsewhere it closely resembles, and of whose presence here there is ample other evidence; or of the sea, whose ordinary work it does *not* resemble, and of whose former presence at this level there is *no* other evidence." The northern ice in the Irish Sea was pressed alternately by the Lake ice from the east, and the Irish ice from the west, and so rose on the two sides of its course at Moel Tryfaen and the Wicklow Hills. It is consonant with this that there is a

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[1] These are now being examined by a committee, including Mr. Bell.

[2] And now also at Gloppa, Oswestry.

[3] The shelly deposits, too, are actually found in the most exposed positions.

deep channel all along the western-centre of the Irish Sea, which he thinks might be carved by the ice where it was thickest.

In Ireland there are limestone boulders at 1,200 ft., which must have been lifted from lower ground, a feat of which floating ice is incapable. As to the thickness of the ice, he takes it at 3,000 ft. on the mountains of Galloway, which, in descending to 1,800 ft. in Wales, would allow a slope of 10 ft. per mile.[1] The contrary slope up to Moel Tryfaen is also very gentle.

As collateral difficulties are the facts that the mountains of Wales had never been submerged since Permian times, and that all marks of submergence suddenly cease south of the Thames, where there were no glaciers to remove the deposits which would have been formed.

***215. Bell, D.—The Great Winter: A Chapter in Geology.**

Proc. Phil. Soc. Glasgow, vol. xxii., p. 261, with plates i., ii.

First a general description of the well-known phenomena is given, with a map of the glacial striæ of Scotland. The idea of great floods is then shown to be untenable, and arguments are adduced against the iceberg theory, viz., the required amount of submergence, which lacks proof, and the distribution of the erratics in well-defined directions. The land ice theory is adopted, and a map is given of the extent of the ice in Europe and America, showing ice covering all parts of England where Boulder Clay is found. This ice must have been 3,000 ft. thick in Scotland by the scratches on Ben Lomond at 2,200 ft. He then discusses the causes. The phenomena are too general to be caused by changed distribution of land and sea, which also lacks independent proof. The objections to Croll's theory are:—1, There is no clear evidence of a sufficiency of recurrences of Glacial Periods; 2, nor of *several* interruptions in the midst of the one which did occur; 3, it assigns too great an antiquity to that period, modern geologists placing it at 8,000—10,000 years instead of 80,000 years ago. He doubts whether any great change is necessary to bring about a glacial period, and after discussing the loss of the earth's heat and the diminution of the sun's radiation, on the whole regards the cause as a still unsolved problem.

***216. Bonney, T. G.—Temperature in the Glacial Epoch.**

"Nature," vol. xliii., p. 373.

The question is asked, "What permanent fall of tempera-

[1] By thickness appears to be meant the height of the top above the sea-level.

ture would produce a recurrence of the Glacial Epoch?" To find the answer he takes as the snow-line the annual isotherm of 32°. He then points out that the glaciers of Switzerland are generated by a mountain district of an average elevation of 1,500 ft. above the snow-line. Hence the Scotch Highlands, and the Cumbrian and the Cambrian hills would be effective glacier-feeding grounds, if the isotherm of 32° coincided with what is now the isotherm of 50°. It is noted also that the glaciers of such a region often go 2,000 ft. below the snow-line. So for other countries the isotherms want reducing to 32°, and it is taken generally that "a lowering of temperature amounting to 18°, if only the other conditions remained constant, . . . would suffice to bring us back the Glacial Period."

216a. Bonney, T. G.—Did Geographical Changes Cause the Glacial Epoch?

"The Contemporary Review," No. 311, Nov., 1891, p. 716.

This is a fuller and extremely interesting article on the same subject as No. **216**. If 1,000 ft. above the snow line be taken as the *minimum* elevation required to produce a glacier-generating snow-field, all the land above this level in Wales would produce glaciers equal to those about the Clariden Grat, and reckoning 1° fall for about 300 ft., another 3° lowering of the temperature, *i.e.*, 21°, would make the land "one vast basin of névé." From the average temperature of the North of Scotland, a lowering of 18° would make it comparable to West Greenland near Fredrickshaab, while Western Scandinavia would have the temperature of Godhaab.

The observations on the Swiss Alps make the snow-line about 700 ft. *above* the isotherm of 32°, and with this modification the glacier-gathering grounds of Wales would be limited to the area above the 1,700 ft. contour.

In Switzerland he reckons the feeding-ground of glaciers to have a temperature of not more than 27°, corresponding to the 9,000 ft. contour. If the general temperature were lowered by 15°, the feeding ground would begin at 3,150 ft., while a lowering of 18° would set the "Moulins" to work again at the "Glacier Garden" at Lucerne, and bring the edge of the ice back to the Pierre à Bot, above Lake Neuchâtel.

In America, a lowering of 16°, or under favourable circumstances even of 12°, would bring back the névé to the forts of Quebec, and suffice to carry the end of the glaciers even to the 40th parallel, where it formerly extended.

He then discusses what causes would suffice for such reductions. From considering the reasons why Siberia and North Canada are so cold, it is concluded that a great extent of

land to the west and south will have an unfavourable influence on climate. The diversion of the Gulf Stream would lower the temperature of North Wales $7\frac{1}{2}°$, and of Cape Wrath 12°. If the British submarine plateau were elevated 1,000 ft., the removal of the coast line to the west, might reduce the temperature 3° and the elevation its 3°—4° more. If this change were coincident with the diversion of the Gulf Stream, glaciers would undoubtedly be formed in the Scotch Highlands. Scandinavia has certainly been higher, but the proofs of British submergence, such as the shells on Moel Tryfaen (which he accepts as evidence) show that ice was present, even when the land was lower. Moreover, we must call in no agencies which would interfere, as elevation might, with the amount of precipitation. He concludes, therefore, that though geographical changes might bring about *a* glacial epoch, they would not suffice for *the* Glacial Epoch—but he will not here discuss the more general causes which have been suggested.

***217. Bulman, G. W.—On the Sands and Gravels intercalated in the Boulder Clay.**

Geol. Mag., Dec. 3, vol. viii., pp. 337–402.

This is an argumentative paper designed to show that these sands and gravels, which are usually referred to an inter-glacial period, may be accounted for by sub-glacial streams, or by oscillations of the extent of the ice. This is done by quotations from various writers as to what is observed regarding these deposits and as to the conclusions they draw. In each case the possibilities of some other cause than an inter-glacial period are pointed out.

CAVES.

218. Jones, E.—Elbolton Cave Exploration.

Rep. Brit. Assoc. for 1890, p. 817.

Elbolton Cave is at the foot of a small scar near Thorpe, 9 miles N. of Skipton. The entrance is a pit 20 ft. deep, leading to a chamber 30 ft. to 40 ft. long by 7 ft. to 13 ft. wide. Its bottom is an upper cave earth 4 ft. to 17 ft. deep. This alone contains evidence of man. Below this is a layer of fragments in clay, of which 15 ft. have been pierced at the west end. Remains of a dozen men have been found, some of whom have been buried. It was also used as a dwelling place, for there are broken bones, charcoal, pot boilers and pottery, but no flint implements, only bone pins. The lower clay contains bones of *Ursus ferox*, and numerous remains of hares, foxes, and reindeer [see No. **322**, 1890].

219. Jones, E.—Report of the Committee, &c., to Complete the Investigation of the Cave at Elbolton, near Skipton, in order to ascertain whether Remains of Palæolithic Man occur in the Lower Cave Earth.

Geol. Mag., Dec. 3, vol. viii., p. 525. Read at Brit. Assoc. in Aug. 1891.

They have now gone down into a fissure 45 ft. below the original level of the floor, but, so far, nothing has been found in the lower deposits but bones of bears, hares, and foxes.

PHYSIOGRAPHY.

***220. Irving, A.—The Geological History of the Thames Valley.**

"Science Gossip," pp. 108 and 135 (abstract of lecture before the Windsor and Eton Sc. Soc.).

The initial uplift to the south took place in early Eocene times, as the London and Hamsphire basins were never continuous after the end of the London Clay period. The London Clay has a thickness of 300 ft. at Hampstead, 270 ft. at Wokingham, 250 ft. at Bearwood, 330 ft. at Wellington College, 370 ft. at Brookwood, 400 ft. at Chobham Place, 450 ft. at Claremont, and 430 ft. at Wimbledon, Showing that the greatest depression was to the south of the present Thames. In later Eocene times the synclinal was accentuated because the Lower Bagshot sands thin out on the sides. Silting up proceeded, and deltaic deposits were laid down transgressively. This is seen on the north side at Wokingham, Bracknell, and Warfield; but on the south side more extensive denudation has obliterated such good evidence, though some outlying sands on the North Downs may be Bagshot. The marine fossils of the Upper Bagshots show there was an estuary opening to the east, and reaching on the west as far as Highclere.

The Wealden elevation, which commenced with the Oligocene Period, attained its maximum during Pliocene times, and was greater in the west than in the east. This made the waters flow northwards towards the Thames Valley, and gave them power to carry detritus; on the other side, the Goring incision commenced, and it was deepened considerably during the Glacial Period, but not so much as 220 ft. —more likely 120 ft. The Thames Valley fault may have fixed the direction of the drainage towards the east, and at the same time the Windsor-Marlow mass may have been elevated, though the bend of the river towards Henley may have been due to extra erosion, when the waters entered in increased

volume from the Oxford Basin. Glacial morainic lakes have been estimated to exist at about 250 ft. above O.D., and near this level have been seen many instances of glacial contortion, of which a beautiful example is figured from a photograph taken at Easthampstead, in Old Windsor Forest. Since then, the valley has been constantly lowered by ordinary subaerial action.

***221. Blake, J. F.—Origin and History of the Thames.**

" Marylebone Mercury," Dec. 12.

The earliest portions of the Thames drainage system are the southern streams, as the Darent, Mole, and Wey, which originally drained the Wealden Isthmus, which lay south of the London sea. When the Cotswolds and Chilterns were uplifted the Lower Thames was formed and driven to run eastwards by the slopes on the N.W. and S., and it had a fall three times as great as at present. The Upper Thames was not yet united to the Lower, but the tributaries which now rise in, or pierce through the Cotswolds combined into a river entering the Wash. Both, however, were tributaries to a larger river draining what is now part of the North Sea. The Pangbourne tributary of the Lower Thames gradually deepened its bed till it took its origin in the valley beyond. Boulder Clay was then brought into the Upper Valley and choked the outlet, so that a lake was formed up to the level of the watershed of the Lower Thames; and pebbles from the Boulder Clay were deposited in gravels. This lake was ultimately drained through the Pangbourne tributary, the Upper and Lower Thames became one river, to which the Kennet was reduced to be a tributary. From this time the history of the Thames as a single river commences—the well-known phases of which are then recounted.

***222. Thomson, S. P.—On the Sources of the River Aire.**

Rep. Brit. Assoc. for 1890, p. 821.

The Aire rises out of the ground at a spot called Aire-head, and is supposed to have flowed underground from Malham Tarn, where there is a water-sink, and to pass by Malham Cove. To test this, the author had thrown 1½ lbs. of a fluorescent substance—uranin—into the water-sink at Malham Tarn (and into one below it), which he expected would colour the water and be seen again at its emergence at Malham Cove or Aire-head. Nothing, however, was seen in three hours, and he concludes that there is either a considerable quantity of underground water between the two spots, or that they are not really connected.

***223. De Rance, C. E.—Subsidence at Wybunbury, near Crewe.**

This point is 7 miles from the nearest salt workings, but there are natural brine springs in the neighbourhood, and it is to the solution of the rock-salt by the water of these that the subsidence is due.

***224. Hopkinson, J.—Excursion to Potter's Bar and Hatfield, for Potterell's Park.**

Proc. Geol. Assoc., vol. xi., No. 9, p. cxl.

Suggests a reason why the name Colne is retained in the upper part of the river for a smaller and less direct stream than a so-called tributary—the Ver. The Ver flows over chalk throughout, and no great change of volume need have taken place in it; but the head waters of the Colne were probably once much larger when they flowed entirely over London Clay. They have, however, since the names were given, cut through this, and reaching the chalk, have made swallow-holes in which much of the water is now lost, thus making the stream smaller.

225. Reid, C.—Excursion to Arundel.

Proc. Geol. Assoc., vol. xi., No. 9, p. clxvii.

Scenery and contours pointed out.

MIXED LOCAL.

226. Holmes, T. V., and Sherborn, C D.—A Record of Excursions made between 1860 and 1890.

London: Stanford, 8vo, pp. 571. Price 12s. 6d. net.

(Geologists' Association separate publication.)

This useful book consists of a modified reprint of the Reports of the Excursions of the Geologists' Association between the years 1860 and 1884 inclusive, those of later date being merely referred to, and it thus gives a key to the demonstrable geology of the various districts visited. It is illustrated by the sections, maps, and views which accompanied the several reports, together with a few from extraneous sources—numbering 214 in all. The excursions are arranged according to districts, and, when more than one visit has been paid, only the new material in the second report is included. The following are the districts here described:—

South-Eastern Counties. *Kent*—Lewisham, Blackheath, Charlton, Westcombe Park, Plumstead, Crossness, Belvedere, Erith, Crayford, Bexley, Bromley, Sundridge, Chislehurst, St. Mary's Cray, Well Hill, Shoreham, Orpington, Knockholt, Sevenoaks, Tunbridge, Tunbridge Wells, Crowborough Beacon, Sheppey, Upnor, Higham, Gorge of

the Medway, Kit's Coty House, Maidstone, Herne Bay, Reculver, Isle of Thanet, Folkestone, Sandgate, Hythe, Romney Marsh. *Surrey*—Croydon, Shirley, Addington, Riddlesdown, Kew Gardens, Richmond, Kingston Hill, Epsom, Dorking, Gorge of the Mole, Box Hill, Leith Hill, Guildford, Chilworth, Caterham, Godstone, Tilburstow, Nutfield, North Downs, Red Hill, Crawley. *Sussex*—Worth, Tilgate Forest, Cuckfield, Hayward's Heath, Ditchling Beacon, Brighton, Lewes, Eastbourne, St. Leonard's, Hastings, Battle. *Middlesex* and *Hertfordshire*—Homerton, Hampstead, Perivale, Hendon, Finchley, Rickmansworth, Watford, Berkhampstead, Bourne End, Radlett, Hatfield, Hertford, Ware. *Essex*—Ilford, Grays, Hangman's Wood, Tilbury Docks, Walton-on-the-Naze.

EASTERN COUNTIES. *Suffolk*—Crag district. *Norfolk*—Norwich, Cromer, Hunstanton. *Cambridgeshire*—Cambridge. *Bedfordshire*—Totternhoe, Kensworth, Luton. *Buckinghamshire* and *Oxfordshire*—Aylesbury, Oxford, Banbury, Chipping Norton. *Berkshire*—Reading, Newbury, Faringdon, Wantage, Camberley.

SOUTHERN COUNTIES. *Hampshire* and *Isle of Wight*.

SOUTH-WESTERN COUNTIES. *Dorsetshire* and *Wiltshire*—Swindon, Salisbury, Stonehenge, Vale of Wardour, Isle of Purbeck, Weymouth, Portland.

WESTERN COUNTIES. *Somerset* and *Gloucestershire*—Yeovil, Bath, Bristol, Aust Cliff, Mendips, Stroud, May Hill, Cheltenham. *South Devonshire*—.*Herefordshire, &c.*—Malvern, Ledbury, Ludlow, Longmynds, North Wales Border, Bangor, Snowdon, Holyhead.

MIDLAND COUNTIES. *Warwickshire*—.*Northamptonshire*—. *Leicestershire*—Charnwood. *Derbyshire*—.*Notts* and *Lincolnshire*—Grantham, Nottingham, Lincoln.

NORTHERN COUNTIES. *East Yorkshire*—.*West Riding*—. *Cumberland*—The Lake District.

FOREIGN EXCURSION. Boulonnais.

227. Topley, W.—Note on a Map of England.

Compte Rendu Congrès Géologique International (1888), p. 241.

Explains a small geological map on the scale 100 miles to 1 in.

***228. Carter, W. L.—The Geological History of England.**

Trans. Leeds Geol. Assoc., part vi., p. 59.

A *résumé* of A. J. Jukes-Browne's "Building of the British Isles."

229. Marr, J. E.—The Backbone of England.

Trans. Leeds Geol. Assoc., part vi., p. 51.

The Lower Palæozoics in the North of England formed a

plain of marine denudation prior to the Carboniferous deposits; the latter were thrown into a simple anticlinal before Permian times, and later were broken up by a series of "monoclinal faults" forming the depression of Eden Valley and Morecambe Bay, and this folding was continued through Mesozoic times. The Lake District is comparable to the Henry Mountains, and is of laccolitic origin, the summit being subsequently denuded. The valleys of the Pennine chain and of the Lake District need not be older than Tertiary times. The region was subsequently covered by an ice-sheet from which the highest points of the Pennine chain stood out as Nunataks, as in Greenland, and floating ice was not required.

230. Marr, J. E.—Geology of Appleby.

Chapter V. of "A Guide Book to Appleby," by Canon Mathews.

Appleby: 8vo, pp. 71—75.

A very brief article on the slate rocks, Carboniferous beds, New Red Sandstone, and superficial deposits of the neighbourhood.

231. Speight, H. ("Johnnie Gray"). — **Through Airedale from Goole to Malham.**

Leeds: 8vo, pp. lxiv. and 302.

A general guide book, but with a chapter on the geology of the district, pp. v.—xii.

232. Cheetham, W.—A Geological Tour through Durham and Cumberland.

Trans. Leeds Geol. Assoc., part vi., p. 12.

Almer Cliff is a good example of undercutting by sand-blast from the west. The bulk of the paper is a chatty description of a tour.

233. Marr, J. E., and Tiddeman, R. H.—The Geology of West Yorkshire.

Compte Rendu Congrès Géol. Intern. (1888), p. 303.

This description appears to run on already published lines. The following classification of the lower rocks is adopted:—

Silurian	Ludlow	Hard Studford Grits. Dryrigg Flags. Hard Austwick Grits.
	Wenlock	Austwick Flags.
	Llandovery	Zone of *Phacops elegans*. Conglomerates.
Ordovician	Upper Bala	Brachiopod Grit of the Wharfe.
	Middle Bala (Caradoc)	Wharfe Grits. Ashes. Norber Brow Grit.*
	Lower Bala (Llandeilo)	Green Slates of Ingleton.

* In this bed the discovery of *Phillipsinella parabola*, Barr., is recorded.

The Carboniferous and Permian rocks, with their faults, are described, and the Glacial deposits and Victoria Cave. A bibliography (by **W. Topley**), and a map on a scale four miles to the inch are given.

***234. Fox-Strangways, C., and Barrow, G.—Explanation of Horizontal Section. Sheet 130.**

Geol. Survey of England and Wales. Price 2d.

This section runs nearly parallel to the coast, starting at Staithes. The explanation is mainly descriptive of the section itself, the main details having been given in the Geol. Surv. Memoirs. A new boring at Irton, for the Scarborough Waterworks, proves the Upper Calcareous Grit to the east of Pickering. It is—

	ft.	in.
Boulder Clay and Superficial Beds	53	0
Kimmeridge Clay	45	0
Upper Calcareous Grit	46	6
Limestone with *Cidaris* in the upper part	120	6
Lower Calcareous Grit	135	0
Passage to Oxford Clay	28	0
	428	0

***235. Fox-Strangways, C.; Reid, C.; and Barrow, G.—Explanation of Horizontal Section. Sheet 131.**

Geological Survey of England and Wales. Price 2d.

This runs parallel to the coast from Redcar, or 12 miles west of Sheet 130. Besides the general description, the following section is given of a boring at Girrick:—

	ft.
Glacial Deposits	10
Kellaways Rock	34
Cornbrash	14
Upper Estuarine Series	142
Moor Grit	72
Grey Limestone Series	23
Lower Estuarine Series	288
Dogger Ironstone	7
Upper Lias	280
Ironstone Main Seam	

A 31 ft. section at Busco Beck shows the Eller Beck bed 1 ft. 5 in. thick, but the best section of this is in Winter Gill, where a 40 ft. 10 in. section shows 7 ft. of it as ironstone. A good section of the Middle Lias Ironstone series is shown at the outflow of Bank House beck. It is here 26 ft. thick, in 21 beds of various material, but the ironstone itself is too thin, 3 ft. 2 in. in all; to be worth working. In Newton Dale a section at Huggitt's Scar shows 8 ft. 6 in. of Cornbrash in four beds, its thickest development in the county, and the Kellaway rock above is 89 ft. 6 in. thick in 10 beds. Sections are also given of borings at Knapton, one showing Kimmeridge Clay 320 ft. in all, and two others showing 95 ft. and 105 ft. of Drift beds.

***236. Fox-Strangways, C., and Barrow, G.—Explanation of Horizontal Section. Sheet 132.**

Geological Survey of England and Wales. Price 2d.

This runs from Middlesbrough to Brandsby. The description includes the Middlesbrough bore-hole section and that of the beds under Burton Head, already published.

***237. Howell, H. H.; Fox-Strangways, C.; and Barrow, G.—Explanation of Horizontal Section. Sheet 133.**

Geological Survey of England and Wales. Price 2d.

From the Magnesian Limestone at Ferry Hill to the Lias at Easingwold in a north and south direction. It gives the section at Kirk Levington through 109 ft. of superficial beds, and 600 ft. of Red Shales and Sandstones of the Trias—the remainder is descriptive.

***238. Fox-Strangways, C.; Reid, C.; and Barrow, G.—Explanation of Horizontal Section. Sheet 134.**

Geological Survey of England and Wales. Price 2d.

From the Cod-beck, east of Northallerton, to the coast at Hawsker. It passes along the strike of the strata, Middle Oolite to Keuper, and gives the sections at Rosedale and at Hawsker.

***239. Fox-Strangways, C., and Reid, C.—Explanation of Horizontal Section. Sheet 135.**

Geological Survey of England and Wales. Price 2d.

From the Lower Lias of Upsall to the Lower Oolite of Gristhorp. All descriptive, with vertical sections from the sheets of the Survey.

***240. Fox-Strangways, C.—Explanation of Horizontal Section. Sheet 136.**

Geological Survey of England and Wales. Price 2d.

From the Lias below the Whitestone Cliff to the coast at Scarborough, illustrating the Middle Oolites on the north side of the Vale of Pickering. Mainly descriptive, with known sections at Hutton Beck and Scarborough.

***241. Fox-Strangways, C., and Barrow, G.—Explanation of Horizontal Section. Sheet 137.**

Geological Survey of England and Wales. Price 2d.

From Knaresborough to Robin Hood's Bay, part of a continuous section across England. Gives sections at Hutton, Newton Dale, Kirk Moor Gate, and North Cheek.

***242. Fox-Strangways, C.—Explanation of Horizontal Section. Sheet 138.**

Geological Survey of England and Wales. Price 2d.

Four Sections are here explained. A. From Hovingham Spa to Flaxton. B. From Slingsby to Barton-le-Willows.

C. From Amotherby to Leppington. D. From Wintringham to Kirkby Underdale, all simply descriptive.

***243. Fox-Strangways, C.—Explanation of Horizontal Sections. Sheet 139.**

Geological Survey of England and Wales. Price 2d.

Along the western escarpment of the Wolds, illustrating the beds which lie below the Chalk. The highest beds of the Lower Oolites at the south end are here called Great Oolite, and considered to be the same as those in Lincolnshire. A section is given of a bore-hole at Stockbridge Lane in the Oolites.

***244. Fox-Strangways, C., and Lamplugh, G. W.—The Geology of East Yorkshire.**

Compte Rendu Congrès Géol. Intern. (1888), p. 371.

The description of the Jurassic rocks by the former of these authors, and of the Cretaceous and Drift by the latter, appears to follow on lines already published. A bibliography (by **W. Topley**) and a map on a scale of 4 inches to the mile are given.

***245. Blake, J. F.—The Geology of the Country between Redcar and Bridlington.**

Proc. Geol. Assoc., vol. xii., p. 115.

A general summary of the already known geology of the district. New figures are given:—1. Section of the coast from Whitby to Filey Brig; 2. Map of rocks between Blea Wyke and Robin Hood's Bay; and 3. Plan of sea-shore from Hawsker to Robin Hood's Bay. The author discusses the line of junction between the Middle and Lower Lias, and states that a line drawn at the base of sandstones would in its course through the country have to cross from one side of a palæontological zone to the other. He suggests that the Inferior Oolite fauna lingered in Yorkshire, when the Great Oolite fauna took its place in the south, but the latter fauna went to die elsewhere. The question of the Neocomian or Portlandian age of Mr. Lamplugh's zone of *Bel. lateralis* at Speeton is also discussed. In favour of the former view, there are quoted the *remanié Lucina portlandica*, the supposed Neocomian age of the Belemnite, the apparently Neocomian character of the fossils called *Am. Asterianus* and *Am. gravesianus*, and the occurrence of *Exogyra sinuata*.

***246. Blake, J. F.; Lamplugh, G. H.; and Cole, E. M.—Excursion to the East Coast of Yorkshire.**

Proc. Geol. Assoc., vol. xii., p. 207.

The already-known geological features of the district as summarised in No. **245**, were verified. At Speeton, Mr. Lamplugh discussed the age of the *Bel. lateralis* beds, holding that this fossil was not necessarily a Neocomian one, nor were the Ammonites, that the *Lucina* was not proved to

be *remanié*, and that the *Exogyra sinuata* was a peculiar form showing more resemblance to some Portlandian forms than to the ordinary Neocomian type. The clays below could not be differentiated from the Kimmeridge. The "compound nodular bed" was well exposed, but the "coprolite bed" was invisible. The Liassic age of the great included mass in Filey Bay was verified, as were the glacial striæ, pointing N. 20° E., on the Corallian rocks near Filey Brig.

247. Wright, G. B. P.—Notes on some Oolitic and Cretaceous Rocks of N.E. Yorkshire.

Proc. London Amateur Sc. Soc., vol. i., p. 58.

A general sketch of the rocks on the coast from Whitby to Flamborough Head.

***248. Hicks, H.—The Geology of North Wales.**

Compte Rendu Congrés Géol. Intern. (1888), p. 267.

[This is not merely a summary of generally accepted facts, but expresses the author's own views, in some cases modified from previous ones.] The following are noticeable points. He speaks of an "overthrust" fault in the Lleyn as having a throw of 16,000 ft. He states that there are pre-Cambrian rocks in the Harlech mountains where Cambrian conglomerates lie unconformably on felsites and schists. The series on the south side of Holyhead Island ["South Stack Series"] he calls Cambrian. The Penrhyn Slates and the Grits at their base are the Caerfai group. The Green Slates with *Conocoryphe* are the Solva group. The Menevian, Maentwrog, Ffestiniog, Dolgelly, and Tremadoc groups are recorded principally from Merionethshire. The ashes and lavas of Arenig Mountain belong chiefly to the Llanvirn group. **G. H. Morton** furnishes the description of the Carboniferous rocks round Llangollen. The rock of Twt Hill and near Ty Croes may be granite. A bibliography is given (by **W. Topley**) and a geological map by the author, scale 4 miles to the inch. In this the masses at Rhos Hirwain and elsewhere in the Lleyn and at Tan-y-grisiau are marked as granite and the boundary of the area said to be pre-Cambrian in the Harlech district is laid down. The rest is in conformity with his previously expounded views.

***249. Blake, J. F.—Sketch of the Geology of the Ancient Rocks of Anglesey and of the North-West of Carnarvonshire.**

Compte Rendu Congrès Géol. Intern. (1888), p. 458.

A short *résumé* of the author's previous publications on the district.

***250. Morton, G. H.—Faulted Areas in the Country around Liverpool.**

Proc. Liverpool Geol. Soc., vol. vi., p. 294.

Numerous faults not noted in the Survey maps have been

laid down on a 6-in. Ordnance map. There are several at Hilbre Point and on Hilbre Island, and another is presumed to exist along the coast of the River Dee, running north and south. At Bidston Hill there are five faults, and in the Storeton quarries twenty-two, and several at the south end of Liverpool, and in the centre of the town. They are so numerous that it is difficult to connect them with certainty.

***251. Mello, J. M.—Handbook to the Geology of Derbyshire. Second Edition.**

London: Bemrose, 12mo, pp. 89, with geological map and five plates.

An admirably written little book, giving the most interesting features in the county geology. Sections reduced from those of the Geological Survey are given. Under Carboniferous Limestone, the fossils, toadstones, tuffs, and minerals are dealt with. The Yoredale rocks are estimated at 500 ft., but the area of those rocks at Ticknall is mapped as Millstone Grit. He considers the Rough Rock at Stannage, and the Bradley and Rowtor Rocks as the result of marine denudation.[1]

A vertical section of the coalfield, and a map from the Coal Commissioners' Report is given. The elevation of the Pennine Chain is admitted to be pre-Permian; but the break between the Permian and Carboniferous is said to be local in this country. No "Keuper Basement Beds" are recognised, and the source of the Bunter pebbles is not allowed to be Scotland, as the pebbles become fewer in number, and at last are absent as we go northwards, "a clear proof that they could not have come from a northern source." He assigns them to a now covered ridge of ancient rocks in Central England. The account of the Drifts is taken from the writings of R. M. Deeley. The Creswell Caves are described, with a list of 23 Mammalia. A photo-tint plate representing 52 various specimens from the caves gives an admirable idea of their contents.

***251a. Arnold-Bemrose, H.—Notes on the Geology of Derbyshire.**

Separate publication. Read to Derby Arch. and Nat. Hist. Soc.

Gives suggestions for work to be done in the country, pointing out the actual condition of knowledge on various subjects.

252. Hind, W.—Excursion to North Staffordshire.

Proc. Geol. Assoc., vol. xi., No. 9, p. 117.

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[1] If these are anything like the Brimham Rocks in Yorkshire, the undercutting power of the sand blast will account for them.

A section is given in Hewitt's Pit, Fenton Low, showing Boulder Clay overlying Coal-measures with the Gutter coal dipping at 15° to S.W., and one in Warrington's Marl Pit, showing the Peacock coal in an anticlinal, overlain by two Boulder Clays, with an intermediate stratified band. A diagrammatic section is also given of Dane's Valley, showing Bunter, Permian, Yoredales, and Millstone Grit, and then a section showing the details of the Yoredales in Butterton Moor Quarry, which was described by **T. Wardle.** It shows some remarkable calcareous gritstones, very suitable for roads. Numerous foraminifera are here found in the Mountain Limestone, especially the Waterhouse Limestone, which is almost made of them. They comprise fifty species of thirty genera, including *Endothyra*, *Valvulina*, *Archaodiscus*, *Saccamina*, and *Carteria*. These have been largely acted on by carbonic acid, which has rendered the limestone amorphous. There are also pyramidal crystals of quartz.

***253. Gilbert, C. J.—The Geology of Sutton Coldfield.**

Privately printed. Berkhampstead. Read before the Vesey Club, 1890.

The Trias beds have been described as a continuous series, thickening to 450 ft., and with a constant dip to E. As a fact, the Bunter conglomerate lies, as a mere shell, upon a Breccia, and there is no continuous dip in it. This Breccia is an unconsolidated purple grit, with fragments of trap, quartzite, and Carboniferous rocks. It varies from a few inches to 20 or 30 ft., and is unconformable alike to the Permian and the conglomerate, and it is suggested that it is a subaerial deposit, when the area was dry land. The conglomerates are of quartzites of various kinds, with Carboniferous Limestone. The Upper Pebble beds are faulted down in the Four Oaks Valley, and Upper Bunter and Keuper, successively to the east. The second has rounded, wind-borne grains, and all are much false-bedded. At Bromsgrove the lower sections of the Hill Top, or Upper Keuper Sandstone, have yielded Calamites. He has not noticed the Lower Bunter Sandstone recorded by J. Landon [*see* No. **196**, 1890], but it can only be in patches. The origin of the Pebble beds he refers to torrents. No unconformity is indicated by the absence of the Muschelkalk. In parts of this district there is no Boulder Clay amongst the Glacial deposits, but only two series of sands and gravels. The upper series may be the local equivalent of the Boulder Clay; it contains foreign blocks from different sources, not indicating different periods, but the overlapping of ice-streams, and there are many local boulders. At Erdington Brickfields is an unstratified clay with similar pebbles, and

on these drifts rest large boulders of Welsh felsite, indicating a later re-advance of the Welsh ice [comp. Martin, No. **318**, 1890].

***254. La Touche, J. D.—Geology of the Woolhope District, and the Local Eruption of Diorite.**

Woolhope Naturalists' Field Club, May 28. (Printed in the "Hereford Times," June 13, 20, 27.)

After a general description, the question is discussed as to the time necessary to effect the denudation of the Woolhope dome after upheaval, and it is estimated at two million years. Mr. **G. H. Piper,** on the same occasion, sent a paper for reading in which catastrophic upheaval and vast waves were looked to as causes of the phenomenon. The observations on the Diorite are general.

***255. Thompson, B., and Crick, W. D.—Excursion to Northamptonshire.**

Proc. Geol. Assoc., vol. xii., p. 172.

A vertical section is given of all the beds from the Cornbrash to the Middle Lias, showing 335 ft. in 30 subdivisions. These are:—1. Cornbrash, 5 ft.; 2—5. Forest Marble Series, 7 ft.; 6. Great Oolite Clay, 9—12 ft.; 7. Transition bed, 6 in.; 8—11. Great Oolite Limestone Series, 26 ft. 9 in.—36 ft. 9 in.; 12. Upper Estuarine beds, 15 ft.; 13. Unconformity—position of Lincolnshire Limestone; 14. Lower Estuarine beds, 12 ft.; 15—17. Variable beds (Northampton Sand), 69 ft.; 18—20. *Jurensis* zone, 13 ft. 6 in.; 21—25. *Communis* zone, 157 ft., including 24 and 25. "Communis" beds, 7 ft.; 26, 27. "Serpentinus" beds, 6 ft.; 28. Fish bed and Paper shales, 1 ft.; 29. Transition bed 6 in.; 30. Marlstone Rock bed, 6 ft.

Detailed sections are first given of the Great Oolite near Wootton in two quarries, and the thinning out of the underlying Northampton sand is noticed; a conformable junction of the Inferior Oolite and Lias was also examined. Next comes a section of beds, 10—12, in Watkins' Brickyard, Hopping Hill; then one of beds, 25—30, at Bugbrook. The section seen at present at Stow Ninechurches (of which a Meisenbach reproduction of a beautiful photograph showing beds 1—6 is given) shows a section from the Oxford Clay to the Ironstone beds of the Northampton Sands. In the Vigo Brickyard at Northampton the Inferior Oolite was thought by the party to be unconformable on the Lias. The bearing of the Moulton brickyard section, with its nodules at the base of the Ironstone, on the question of the presence (Thompson) or absence (Crick) of the *Jurensis* zone in this district, was discussed on both sides, and the suggestion made that part, but only part, of it may be present.

***256. Woodward, H. B.—Explanation of Horizontal Section. Sheet 142.**

Geological Survey of England and Waes. Price 2d.

The section described is from Bishopstone, near Hartwell, through the Oolites and Lias of Buckinghamshire and Northamptonshire (near Buckingham and Daventry), thence through the Lias and New Red Marl of Warwickshire from Rugby to near Wibtoft. It was published in 1886.

The Gault here attains a thickness of 230 ft.

The Lower Greensand at Stone is composed of:—3. Brown ferruginous and pebbly sands; 2. Yellow, grey, and blue clays, 6 ft.; 1. Grey and white quartz sands, 16 ft.

The sections of the Portland and Purbeck at Hartwell are given, and it is recognised that the Hartwell Clay is the equivalent of the Middle Portlandian of Boulogne [Bolonian]. They are also compared with the clays *above* the "Portland Sand" at Swindon.[1]

The Kellaways Rock occurs in the form of yellowish sand separated from the Cornbrash by 12 ft. of clay. The Cornbrash is not more than 10 ft. thick, and the Forest Marble 6—12 ft. The Great Oolite series comprises Great Oolite 7 ft., Upper Estuarine series 1 ft. 6 in.; and the Inferior Oolite comprises Lower Estuarine 12 ft., Northampton Sands 3 ft. 6 in.—10 ft. The Upper Lias is 150 ft. thick, at the base is the Fish bed 3 ft., and the Transition bed 3 in.—4 in.; the Marlstone is 10 ft. thick, and is used for building stone; the entire Middle Lias being 60—100 ft. By an old boring we learn that the Lower Lias is 458 ft. thick, and the Rhætic and Keuper over 677 ft. West of Church Lawford the Rhætic or White Lias is 5—6 ft., Grey green Marls 5—8 ft. At Tingewick, west of Buckingham, 40 ft. of Boulder Clay, some chalky, is seen.

***257. Green, Upfield.—Excursion to Shenley.**

Proc. Geol. Assoc., vol. xi., No. 9, p. clxix.

The bed of Puddingstone, previously believed to be *in situ*, was now seen to consist of lumps, lying on recomposed clay and sand. These lumps are believed to have been brought there from the west by a stream flowing east, when at a higher level, the cementing silica being derived from silicates in the Drift.

***258. Holmes, T. V.—The Geology and Scenery of the Club's Voyage from Maldon to Chelmsford.**

"Essex Naturalist," vol. v., p. 197.

General notes, amongst which is a discussion of the reversed fault in the Wickham Bishop Well, of which a new

[1] These doubtless belong to the same series, but there are Bolonian clays *below* the Sands at Swindon.

diagram is given. Beacon Hill and Danbury are thought to have no connection with this fault, but to owe their unusual height to being in a synclinal.

*259. **Holmes, T. V.—Excursion to Walton-on-the-Naze.**

Proc. Geol. Assoc., vol. xi., No. 9, p. cl.

The ordinary geology of the district is described.

260. **Goodchild, J. G.—The Geology of Erith and Crayford.**

Compte Rendu Congrés Géologique International (1888), p. 450.

A short account of the geology of the district, compiled from various sources.

*261. **Spurrell, F. C. J.—Excursion to Crayford.**

Proc. Geol. Assoc., vol. xi., No. 9, p. cxliv.

A layer of till, 5 to 7 ft. thick, is here seen intercalated with the sands near the cliff; it is full of stones, &c., dragged from a former land surface.

*262. **Spurrell, F. C. J.—Excursion to Swanscombe.**

Proc. Geol. Assoc., vol. xi., No. 9, p. clxv.

Flint implements are here met with in Dartford gravel.

*263. **Leighton, Thos.—On Recent Discussions relating to the Geology of the South-East of England.**

Twentieth Ann. Rep. S. London Micr. and N. H. Club, p. 9.

Gives a general sketch of the geological history of S.E. England, and discusses the Lenham beds, whose Pliocene age involves the early denudation of the Weald, down to the Lower Greensand, which is considered to be the source of the Lenham sand.

264. **Lobley, J. L.—Surrey.**

"The Land Roll," October, 1891.

A pleasantly-written account of the geology of the county in relation to its soils, dividing it into six districts—1. The Thames valley, highest point 376 ft. at Crystal Palace; 2. the Downs, highest point Botley Hill, 877 ft.; 3. Holmsdale, highest point High Chart, 663 ft.; 4. the Lower Greensand Bridge, highest point Leith Hill, 963 ft.; 5. the Bagshot Area, highest point Romping Downs, 390 ft.; 6. the Weald Valley, highest point Holmwood Common, 350 ft.

*265. **Woodward, H. B.—Description of the Routes towards London.**

Compte Rendu Congrès Géologique International (1888), p. 245.

Gives the general and well known geology of the country, (*a*) from Southampton to London; (*b*) from Newhaven to

London; (*c*) from Boulogne to London *viâ* Folkestone; (*d*) from Calais to London *viâ* Dover; (*e*) from Harwich to London, with sections from previously-published sources.

266. Drew, F.—Notes for the Excursion to Windsor and Eton.

Compte Rendu Congrès Géologique International (1888), p. 447.

A general sketch of the geology of the district.

267. Strahan, A., and Reid, C.—The Geology of the Isle of Wight.

Compte Rendu Congrès Géologique International (1888), p. 347.

This follows throughout the recently-published Geological Survey Memoir (*see* Nos. **234**, **241**, **270**, 1890). A bibliography (by **W. Topley**) and a map on a scale of four miles to an inch are given.

***267a. Blake, J. F., and Leighton, T.—Excursion to the Isle of Wight.**

Proc. Geol. Assoc. vol xii., p. 145.

The strata examined were at the west end of the island. A long discussion is given on the retention of the name "Hempstead Beds" for the Oligocene at Hamstead, principally on account of its priority, which on the other hand was objected to as involving an absurdity. A figure is given of the contorted Headon Clays in Colwell (misprinted Totland) Bay. Messrs. Keeping and Tawney's reading of the sequence along the west coast is upheld. A banded discoloration of the Bembridge marls simulating false bedding, and an apparent terminal curvature of the Lower Eocenes in Alum Bay (figured) were noticed. The London Clay contains clay pebbles at its base, indicating an eroded surface. In Compton Bay a thick deposit of chalk rubble was noticed, which is spoken of in the Survey Memoir as "the run of the hill," but which seems to demand other conditions than those at present obtaining. Attention was drawn to the landslips occurring at the two ends of the Undercliff, and not in the centre, and to the effect of jointing on the direction of the coast line east of Luccombe Chine.

268. Reid, C., and Strahan, A.—Explanation of Sections across the Isle of Wight from North to South, illustrative of the Geological Map.

Geol. Survey. Horizontal Section, No. 47. Price 2d.

There are four sections explained. No. 1, from Hamstead Lodge to Sedmore Point; No. 2, from Osborne Pier, through St. George's and St. Catherine's Downs to Rocken End; No. 3, from Binstead, through Ashy, Shanklin and St. Boniface Downs to Ventnor; No. 4, from Sea View through Bembridge Down to Sandown Bay. These sections were

published in 1889, and the full explanation is contained in the Memoir. [*See* No. **134**, 1890.]

269. Green, A. H.—Excursion to Oxford.

Proc. Geol. Assoc., vol. xi., No. 9, p. 146.

The ordinary geology of the district is described.

***270. Bennett, F. J.—Influence of Geology on Settlement around Marlborough.**

Rep. Marlborough Coll. Nat. Hist. Soc., No. 39, p. 71.

The open Chalk Downs for pasture, the flints for implements, the neighbouring forest of Savernake on the Tertiary beds for game, and the Sarsen stones for shelter and temples, determined the Neolithic people to settle on the site now occupied by Marlborough. The long stripe-like parishes on the slopes of the Chalk escarpment are intended to include for each an equal share of the advantages the various geological strata afford. The presence of the Chalk Rock has determined several of the hill-forts, as at Martinsell, Barbury, Leddington, White Horse Hill, and Uffington Castle. The Melbourn Rock is only seen north of Wootton Rivers.

***271. Woodward, H. B.—The Geology of the Vale of Wardour.**

Compte Rendu Congrès Géologique International (1888), p. 463.

A short description of the geology of the district compiled from various sources.

***272. Winwood, H. H.—The Geology of the Environs of Bath.**

Compte Rendu Congrès Géologique International (1888), p. 472.

A brief account of the rocks from the Old Red Sandstone to the Upper Chalk. He calls the reversed fault of Radstock a "slide" or "overlap fault," and retains the term "Midford Sands." A map of about 4,800 square miles, reduced from the Geological Survey by **H. B. Woodward,** on a scale 2 miles to the inch, is given.

***273. Woodward, H. B.—Brief Notes on the Geology of the Mendip Hills, with Reference to the Long Excursion [of the Geologists' Association], August 4th to 9th, 1890.**

Proc. Geol. Assoc., vol. xi., No. 9, p. 481.

This paper is a *résumé* of the published descriptions of the district, and mentions the discovery by J. Phillis of *Terebratula Morieri* in the *Parkinsoni* zone at Doulting.

***274. Winwood, H. H., and Woodward, H. B. —Excursion to the Mendip Hills.**

Proc. Geol. Assoc., vol. xi., No. 9, p. clxxi.

The unconformability of the Secondary rocks on the Carboniferous limestone in several classical localities was first

demonstrated, and then the misplaced limestone at Vobster was discussed, **Mr. McMurtrie** explaining it by an overfold, the coal being worked beneath it, and possibly by a subsequent slip. Some details are given with respect to an intrusive rock at Moon's Hill Quarry, described by F. Rutley as a "porphyritic pitchstone." The porphyritic structure is microscopic, the insets being of plagioclase and hornblende, the ground mass showing fluidal structure. It is altered, and the felspars are zoned. The rock is associated with a breccia. The "Wells" to which that town owes its name are springs which rise in the Mendips and flow underground, and reappear at a weak point in the New Red Marls. (A note here gives the opinion of the director, **H. B. Woodward,** with regard to the "divining rod," the most that is allowed for it being that, "held in a position that somewhat strained the muscles, it might assist the individual in coming to a decision," or he might feel "a slight chilliness" when water was near—in other words, the "diviner" could do as well without his "rod.")[1]

On a later day a discussion took place on the origin of the Cheddar Gorge, the director, **H. H. Winwood,** maintaining that it was entirely due to chemical and mechanical erosion, since the limestone is continuous across the base; and **Jas. Parker** referring it almost entirely to fracture during upheaval, but his reasons are not cited.

In the raised beach at Weston-super-Mare, 25 ft. above sea-level, were found *Littorina littoralis* and *L. rudis*, and in the blown sand above, fragments of *Tellina balthica.*

The Steep Holme was found to be composed of thin and flaggy fossiliferous limestone—belonging to the Upper Limestones, thrown into a steep anticlinal. The Flat Holme consists of the same, in low anticlinal and synclinal folds, with a beach on N. side of yellow-coated flints, quartzite, red and purple porphyry, Lydian stone, granite, jasper, and limestone, which, as far as all evidence goes, were brought there by natural causes. A well was here observed which contains brackish water, and is said to fill at ebb, and fall at flood tide.

The remainder of the observations were on the well-known features of the district.

275. Seward, E.—Notes on a Slab of Fossiliferous Marble found at Marston Magna, Somersetshire.

Rep. and Trans. Cardiff Nat. Soc., vol. xxii., p. 8.

An exhibited piece of Lias with *Ammonites planicosta*, gives occasion to a brief general description of the geology of Somerset.

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[1] This seems to be the prevalent idea amongst geologists, but it is scarcely deducible from the known facts.

276. M'Lennan, J. S.—The Geology of the Lugton Valley.

Trans. Geol. Soc. Glasgow, vol. ix., part i., p. 91.

A general account of the rocks met with in the district, summarising already known facts.

277. White, J.—Notes on Gairloch, Ross-shire.

Trans. Geol. Soc. Glasgow, vol. ix., part i., p. 192.

A general discussion of points raised in this district. He agrees to the glacial origin of the mound-like surface of the Archæan gneiss overlain by the Torridon Sandstone, which in places is quite a breccia at the base.

278. Milne, J.—Geology of Buchan.

Proc. Buchan Field Club.

Not seen.

WELL SECTIONS AND BORINGS.

279. De Rance, C. E.— Sixteenth Report of the Committee . . . . appointed for the purpose of Investigating the Circulation of Underground Waters in the Permeable Formations of England and Wales, &c.

Rep. Brit. Assoc. for 1890, p. 352.

The following are the borings given :—

LANCASHIRE :

Presall End.—544 ft. Permian Sandstone.

Fleetwood.—88 ft. Boulder Drift, 471 ft. Red Marl.

Halewood.—164 ft. Red Sandstone, 67 ft. Red Permian Marl.

Kirby Waterworks, (1) 442 ft. Pebble Beds, 68 ft. Permian Sandstone?

Knowsley (2).—199 ft. Pebble Beds ?, 222 ft. Permian Sandstone.

Ordsall.—761 ft. Trias Sandstone, 149 ft. Permian Marls, 326 ft. Permian Sandstone.

Salford.—390 ft. Pebble Beds, 158 ft. Permian Marls, 118 ft. Permian Sandstone.

Oxford Road, Manchester.—114 ft. Pebble Beds, 432 ft. Red Marls and Sandstone.

Ardwick.—166 ft. Bunter Sandstone, 167 ft. Permian Marls, 184 ft. Collyhurst Sandstone, 7 ft. Coal-measures.

Cheetham.—258 ft. Pebble Beds, 161 ft. Permian Marls, 107 ft. Red Sandstone.

Medlock Vale.—26 ft. Drift, 23 ft. Trias Sandstone, 245 ft. Permian Marls, 424 ft. Permian Sandstone, 143 ft. Coal-measures.

Heaton Chapel.—10 ft. Boulder Clay, 305 ft. Permian Sandstone, with band of Marl.

Heaton Norris.—18 ft. Drift, 163 ft. Red Rock, with band of Marl.

Heaton Mersey.—97 ft. Pebble Beds, 496 ft. Permian Sandstone, with Marl and Limestone bands.

CHESHIRE :

Edgeley.—75 ft. Drift, 26 ft. Upper Bunter, 424 ft. Pebble Beds.

Stockport.—87 ft. Drift, 12 ft. Rock.

——————51 ft. Permian Marl, 209 ft. Red Sandstone and Marl.

Stockport.—145 ft. Red Marl, 36 ft. Sandstone and Marl.
————11 ft. Gravel, 77 ft. Soft Red Sandstone, 30 ft. Marl, 34 ft. Red Sandstone.
————90 ft. Drift, 182 ft. Permian Marls and Sandstone.
Bollington.—100 ft. Drift, 300 ft. Pebble Beds, 105 ft. Permian Marl and Sandstone.
Chadkirk.—10 ft. Gravel, 370 ft. Dark Grey Shale, 222 ft. Millstone Grit and Shale.
Altrincham.—102 ft. Drift, 175 ft. Red Marl and Sandstone, 30 ft. Grey Marl and Sandstone.
Frodsham.—12 ft. Alluvium and Drift, 130 ft. Red Sandstone.

NOTTINGHAMSHIRE:

Chilwell.—13 ft. Alluvium, 16 ft. Keuper, 250 ft. Pebble Beds, 33 ft. Lower Bunter, 876 ft. Coal-measures.
Highfield House—22 ft. Alluvium, 234 ft. Bunter Sandstone, 47 ft Coal-measures.
Sawley.—25 ft. Gravel, 139 ft. Keuper Marls and Sandstones.
Weston.—14 ft. Gravel, 138 ft. Keuper Marls and Sandstones.
Stanton.—120 ft. Millstone Grit series.

YORKSHIRE:

Snaith.—930 ft. New Red Sandstone, 20 ft. Magnesian Limestone.
Lackenby.—597 ft. Upper Gypseous Marls, 598 ft. Red Sandstone, 448 ft. Lower Gypseous Marls, 42 ft. Anhydrite Beds, 119 ft. Rock Salt, 2 ft. Anhydrite.

WARWICKSHIRE:

Spon End, Coventry.—195 ft. Red Sandstone and Marls.
———— 170 ft. Red Sandstone and Marls, 75 ft. Pebble Sandstones, 55 ft. Red Marl and Sandstone.
———— 378 ft. Marls and Sandstones, 48 ft. Coal-measures.
(3)———— 575 ft. Red Marls with "fish eyes," Red Sandstones, and some conglomerates, 78 beds.
Stockingford —67 ft. Clay, 327 ft. Red Rocks and Marls in 31 beds.

(1) Yields a million gallons daily.
(2) Yields 1½ million gallons daily.
(3) [*See* No. **195**, 1890.]

*280. Brockbank, W.—On the Occurrence of the Permians, Spirorbis-Limestones, and Upper Coal-Measures at Frizington Hall, in the Whitehaven District.

Mem. and Proc. Manchester Lit. and Phil Soc., vol. iv., No. 4, p. 418.

The Middle Coal-measures of the Whitehaven coal-field are worked at Cleator Moor, and the measures are then cut off by the Weddiker Hall fault. To prove the strata beyond this fault, a bore-hole has been put down near Frizington Hall, which reveals a series of deposits not before known in the Whitehaven district. Of this bore-hole a complete section is given, showing 66 subdivisions in 573 ft., of which the following is a summary:—

		ft.	in.
	Surface clays	22	0
A	Permian breccia	20	0
	Red and mottled shales	16	4
	Soft purple sandstones	9	2
	Various coloured shales	43	7

B	Reddish limestone (*Spirorbis*) ..	..	3	9
	Purple sandy shales ..	..	10	8
C	Conglomerate	..	11	0
	Mottled shaly sandstone ..	..	6	0
D	Shaly conglomerate ..	..	39	1
	Red shales	..	6	0
	Sandstones, various ..	..	57	8
	Red shale, &c.	..	16	3
E	White limestone (*Spirorbis*) ..	..	1	0
	Shales and marls	..	23	6
	Sparry sandstone with hæmatite	..	1	6
	Shales and blue metal ..	..	8	10
a	Brassy coal	..	0	4
	Blue metal (*Stigmariæ*) ..	..	2	9
	Grey sandstones	..	1	0
	Blue metal	..	14	8
b	Coal	..	1	0
	Metal and shales	..	88	11
c	Coal	..	1	3
	Metal and shale	..	11	8
	Red sandstone	..	6	11
	Red shales	..	12	2
	Red grey sandstones ..	..	6	4
	Red sandy shales	..	6	0
	Reddish sandstones ..	..	10	4
F	Hard grit	..	17	2
	Red and mottled shales ..	..	31	1
	Purplish sandstone ..	..	21	7
G	Conglomerate	..	11	10
	Reddish sandstones ..	..	11	6
	Dark smooth purple shales..	..	7	0
	Reddish sandstone ..	..	12	5
			573	3

A is the Permian Breccia with fragments of the Borrowdale Volcanic series, Skiddaw slates and the underlying Carboniferous Limestone with *Spirorbis*. This same Breccia is found on the surface in Dub Beck, and at Mill Yeat, hæmatite has been worked beneath it. This mineral and the underlying Coal-measures may be expected all over the district eastwards, where they have not hitherto been seen. The underlying rocks in general are similar to the series exposed at Levenshulme [described in No. **104**] including the conglomerates C and D. The limestones B and E contain *Spirorbis* and entomostraca, and are spotted like those of Levenshulme, and show imperfect "fish eye" mottlings; the upper one contains Silica 2·8, Alumina and Iron 1·2, Carbonate of Magnesia 4·2, Carbonate of Lime 91·8. These then are the Upper Coal-measures with the coals a, b, c not hitherto known. The Grit and Conglomerate F and G are the Whitehaven Sandstone, which lies, therefore, below the Upper Coal-measures and not unconformably above them, as previously supposed.

281. De Rance, C. E.—Notes on Borings for Water and Salt in the County of York.

Proc. Yorkshire Geol. and Polyt. Soc., vol. xi., pt. iii., p. 424.

This is a general summary, first, of the area of various surface rocks from the Carboniferous to the Chalk, and, secondly, of the borings which have been made in each—all of them already recorded. These borings include those at Middlesbrough, Lackenby, Kirk Lavington, Selby, Towthorpe Common, York, Goole, Holme, Saltmarsh, Doncaster, Salton near Malton, Irton, and Bridlington Quay.

282. De Rance, C. E.—Borings in the Keuper Marls.

Trans. Manchester Geol. Soc., vol. xxi., p. 169.

The marl is discoloured next the bands of gypsum, and a brecciated appearance is produced by the strings of the same.

***283. Whitaker, W.—The Geology of Parts of Cambridgeshire and Suffolk.**

Mem. Geol. Surv. Appendix II.

The following wells and borings are recorded:—

Cambridgeshire.—Barraway. Gault? 27 ft.
Cottenham. Gault 20 ft., L.G.S. 18 ft., K.C. 39 ft.
Ely. Legges Brewery. L.G.S. 15 ft., K.C. 5 ft.
Isleham. Chalk 70 ft., Gault 6 ft.
Soham. Chalk 16 ft., Gault 4 ft.
——— Chalk 14 ft., Gault, 90 ft., L.G.S. 12 ft.
Cambridge. Chalk 173 ft., Gault 192 ft., Greensand 68 ft.
Linton. Drift 20 ft., Chalk 100 ft.
Newmarket. Moulton Paddocks. Chalk 150 ft.
——— Sefton Lodge. Chalk 177 ft.
Pampisford. Chalk 125 ft.
Swaffham Bulbeck. Chalk 93 ft., Gault 93 ft., L.G.S. 10 ft.
West Wickham. Drift 53 ft., Chalk 73 ft.
West Wratting. Drift 34 ft., Chalk 115 ft.
Huntingdonshire.—Bluntisham. Drift, Oxford Clay, 32 ft.
Norfolk.—Thetford. Drift 50 ft., Chalk 155 ft.
Suffolk.—Ampton. Drift 70 ft.
Cavenham. Drift 25 ft., Chalk 30 ft.
Culford. Chalk 87 ft.
Flempton. Drift 25 ft. and 18 ft.
Hengrave. Brick-earth 15 ft., Chalk 14 ft.
Herringswell. Sand 5 ft., Chalk 20 ft.
Icklingham. Brick-earth 30 ft., Chalk 30 ft.
Ingham. Drift 30 ft., Chalk 40 ft.
Lackford. Drift 5—8 ft., Chalk 70 ft.
Livermere. Drift 20 ft.
Mildenhall. Chalk 250 ft., U.G.S. 10 ft., Gault 10 ft. (doubtful).
Bawdsey. Crag 16 ft., London Clay 87 ft., Reading Beds 46 ft., Chalk 151 ft.
Brantham. London Clay 55 ft., Reading Beds 49 ft., Chalk 95 ft
Clare. Doubtful 155 ft., Chalk 227 ft.
Eye. Drift 50 ft., Crag or Drift 39 ft., Chalk 111 ft.
Glemsford. Drift 120 ft., Chalk 30 ft.

Ipswich. Mason's Paper Mills. Gravel 29 ft., Chalk 371 ft.
——— Tollemache's Brewery. Gravel 22 ft., Reading Beds 12 ft., Chalk 186 ft.
——— Waterworks. Drift 20 ft., Thanet Sands 18 ft., Chalk 407 ft.
Kelsale. Drift 106 ft., Crag 45 ft., Chalk 291 ft.
Melton. Crag, &c., 74 ft., London Clay 17 ft., Reading Beds 35 ft., Chalk 244 ft.
Withersfield. Drift 105 ft., Chalk 55 ft.
Thorndon. Drift 87 ft., Chalk 180 ft.
——— Drift 108 ft., Chalk 160 ft.

*284. Jukes-Browne, A. J.—On a Boring at Shillingford, near Wallingford (on Thames).

"Midland Naturalist," vol. xiv., p. 201.

This boring gave the following section:—

		ft.	in.
	Soil and made ground	4	0
	Sand and gravel	15	0
Gault	Grey clay	81	0
	Darker grey clay	63	0
Vectian or Lower Greensand	Yellowish green sand with quartz-pebbles	10	0
	Hard sand-rock	4	0
	Greensand and pebbles	6	0
	Greensand, loamy	1	0
	Loose pebble sand	2	9
	Fine loamy yellow sand	1	3
Kimmeridge Clay	Stiff grey clay and stones	20	0
	Black clay, with shells and stones and phosphate nodules near the base ..	91	6
Coral Rag?	Rock	12	9
	Stony clay and shale	4	8
	Rock, with layers of clay	10	0
	Stony clay, with layers of rock ..	8	10
	Rock, with shell fragments	7	7
Lower Calcareous Grit.	Sand and stone	7	4
	Alternations of hard grey rock and clay ..	10	4
	Clay and shells	10	0
	Hard grey Limestone	2	6
	Sand and stone with water	5	0
Oxford Clay.	Blue clay, soft and slightly mottled ..	4	6
		384	0

The total thickness of the Gault is estimated as 187 ft., as the well does not start at the top. The Vectian is seen to have not yet died out. If the part assigned to the Coral Rag is really such—it has changed its character from its outcrop. The water from the Vectian sands is salt, and gives the following analysis:—

	Grs. per Gallon.
Calcium sulphate	10·54
Magnesium sul[illegible] ..	3·02
Calcium carbo[illegible] ..	1·00
Potassi[illegible] ..	[illegible]·17
Potas[illegible]	0·83
Sod[illegible]	[illegible]·79
S[illegible]	2·24
[illegible]	2·28

There is no oxide of iron—and at first the water was salter. The salinity is discussed, and it is suggested that it is the natural water of the original stratum, which is confined to it by the running together of the Gault and Kimmeridge Clay further to the east on the dip.

285. Murdock, J. B.—Journal of a Bore put down for Water at Thornliebank, Renfrewshire.

Trans. Geol. Soc. Glasgow, vol. ix., part i., p. 207.

The bore is 611 ft. 6 in. deep, but no water was found. It is in Carboniferous strata. Details of 175 beds are given which may be summarised as follows:—

	ft.	in.
"Fakes and Blaes" with bands of limestone ..	201	6
Limestone (probably Arden cement)	6	10
Fireclay and Fakes	6	2
White Sandstone	17	1
Blaes and Fakes, &c.	10	0
White Sandstone (probably the Giffnock) ..	49	3
Sandstones and Fakes with a thin Coal Band ..	188	3
Limestone (probably the Cowglen)*	7	4
Fakes, Blaes and Sandstones, with a thin Coal Band	126	3

* [Called "Arden" in the detailed section.]

MISCELLANEOUS.

286. Frazer, P.—Reports of American Committees to the International Congress of Geologists.

Compte Rendu Congrès Géologique International (1888), Appendix A., pp. 219.

This is a series of reports of various sub-committees on the classification of Archæan, Lower Palæozoic, Upper Palæozoic, Mesozoic, Cenozoic, and Quaternary and Recent rocks. It consists principally of the expression of the opinions of various geologists on the questions submitted to them, and deals almost entirely with American rocks.

***287. Hughes, T. McK.—Reports of the British Sub-Committees on Classification and Nomenclature. 2nd Edition.**

Compte Rendu Congrès Géologique International (1888), Appendix B., pp. 178.

This has been mainly reprinted, and does not appear to differ in any noticeable respect from the previous issue.

288. Dewalque, C.—Committee for the Unification of Nomenclature.

Compte Rendu Congrès Géologique International (1888), Appendix C., pp. 10.

This is already published material, principally posing questions for discussion at the Congress—three only out of eight of which were actually discussed.

289. Morton, G. H.—List of Works and Papers on the Geology of the Country around Liverpool from June, 1881, to September, 1890, with some additions to the former Lists.

Proc. Liverpool Geol. Soc., vol. vi., pp. 297.

Ninety-two publications are here recorded.

290. Harker, A.—Bibliography, Geology, and Palæontology [Relating to the North of England].

"The Naturalist" for 1891, pp. 313–330.

Two hundred and two entries arranged alphabetically by authors' names.

PALÆONTOLOGY.

HUMAN IMPLEMENTS.

***291. Prestwich, J.—On the Primitive Characters of the Flint Implements of the Chalk Plateau of Kent, with reference to the Question of their Glacial or Pre-Glacial Age.**

Journ. Anthropological Inst., vol. xxi., p.246, pls. xviii.–xxi.

These implements are found in the Plateau Drift capping the chalk escarpment east and west of the Darent valley, at heights sloping from 700 or 800 ft. down to 400 ft. A list is given of the number and locality of the implements found up to the present time, being 1,277 from the east plateau and 236 from the west. From their occurring on the remains of an uniform surface, since carved into valleys, they are presumably older than the implements found in those valleys, provided always they are of the same age as the drift with which they occur. Only a very few, however, at present have been obtained in the red-clay drift, most of them, naturally, occurring on the surface. They present, however, physical characters due to having been embedded in a special drift and are confined to a special area. It is not so much their rudeness as their type that distinguishes them from the valley implements, the only ones like them amongst the latter are worn and derived, and these are very scarce.

The differences are as follows. The valley implements are usually made from large flints derived directly from the chalk, and very seldom from the gravel-flints. Eight varieties of form are mentioned, of which the commonest are pointed, and having the haft end either the natural surface of the flint,

or worked out; spatula shaped; or ovoid, either flat or with a central twist. The plateau implements, on the other hand, are almost all more or less stained of a warm brown colour, they are usually a good deal rolled or knocked about, the trimming is often very slight, suitably shaped natural flints having been selected; and besides those with definite patterns there are many which have been simply chipped by use, but in such a way as could not result from natural wear. There are, however, a few—about five per cent., which might pass for valley specimens of the ovoid or pointed type, whose presence it is not easy to account for.

They may be classified in three groups. (1) Those in which the natural flint has been used with little modification, of this group three types are noted; (2) natural flints, but worked for some object to a common pattern, of which nine types are noted; (3) implements worked entirely out of the flint, as in the later palæolithics, of which five types are noted. The relative abundance of those collected belonging to these groups is 40, 54, and 6; of these the second group is the most characteristic, particularly crescent-shaped scrapers [fig. 112], double scrapers, including the pointed [fig. 109], and the depressed [fig. 110] and beak-shaped implements [fig. 111].

He concludes that the makers of these were not contemporary with the Valley Drift men, but belonged to an early Glacial or pre-Glacial period. Plate 18 is a map showing the localities in the plateau drifts and valley drifts where the implements have been found, and plates 19—21 illustrate the three groups of the plateau implements.

***292. Harrison, B.—On certain Rude Implements from the North Downs.**

Journ. Anthropological Inst., vol. xxi., p. 263.

Gives an account of how he was led on to collect the rude types on the plateau, and of where three were found embedded in the clay. He classes them provisionally as (1) crook point tool [fig. 111]; (2) single curve scraper; (3) double curve scraper [fig. 109]; (4) combination tool; (5) split pebble with work on one side; (6) semi-circular tool; (7) drawshave or hollow scraper [fig. 112]; (8) tool with work all round. The peculiar thing about these is the abundance of implements of the same type. Of these implements 600 have been sketched and catalogued.[1]

***293. Crawshay, De B.—Notes on the Western Chalk Plateau.**

Journ. Anthropological Inst., vol. xxi., p. 267.

Amongst his collection from the district he has very few

[1] This number is now increased to 1,600.

plateau types from the valleys below 400 ft. and no valley types from the plateau. From the west plateau he has collected 198, and from the east 178. The derived plateau types, on the valley surface, on the west side of the Darent number 4, and on the east side 15, and to the north of the clay with flints, only 10 out of 200.

294. Stopes, H.—Indication of Retrogression in Pre-Historic Civilisation in the Thames Valley.

Rep. Brit. Assoc. for 1890, p. 979.

Already published separately in 1890. [*See* No. **361**, 1890.]

***295. Harrison, B.—Report of the Committee, &c., appointed to Carry on Excavations at Oldbury Hill, near Ightham, in Order to Ascertain the Existence or Otherwise of Rock Shelters at this Spot.**

Geol. Mag., Dec. 3, vol. viii., p. 524. Read at Brit. Assoc. in Aug., 1891.

After some ineffectual attempts, the slope of the spur of Mount Pleasant was found on working over to yield 49 well-finished Palæolithic implements, and 648 waste flakes, some so small as to lead to the supposition that here was the workshop, and the adjacent rock the frontage of a rock-shelter.

***296. Knowles, W. J.—Second Report on the Pre-Historic Remains from the Sand Hills of the Coast of Ireland.**

Proc. Roy. Irish Acad., 3rd series, vol. i., p. 612, plates xxii., xxiii.

The sand hills are found all round the coast and in islands, and contain bones and relics, as at Bunbeg, co. Donegal; Ballyness, co. Donegal; Killala, co. Mayo; Grangemore, co. Londonderry; and at Whitepark Bay, co. Antrim, where were numerous flint arrows, scrapers, cores, flakes and hammerstones, with bones of *Bos longifrons*, *Cervus elaphus*, sheep or goat, pig, fox, the great auk, goose, gull, and cod.

297. Armstrong, J. N.—The Antiquity of Man.

"The Rochester Naturalist," vol. ii., p. 49.

A general summary of the arguments for his great age.

***298. Brooke, J. W.—Notes on Neolithic Flints.**

Rep. Marlborough Coll. Nat. Hist. Soc., No. 39, p. 103.

During the year 1890, 2,964 Neolithic flints have been obtained by the author near Marlborough. The Pantawick flints are the most primitive, many having no definite shape; but only chipped on one side. Out of 100, there would be 23 scrapers, 40 knives, 10 skin-dressers, 24 flakes, 2 arrow tips, and 1 celt. Albourne was the most important centre of manu-

facture. Here, out of 100, there would be 15 scrapers, 15 knives, 9 skin-dressers, 7 strike-a-lights, 4 fabricators, 18 flakes, 6 sling stones, 16 arrow tips, and 10 celts. On Windmill Hill, Avebury, probably an old battle-site, were found 5 knives, 7 scrapers, 1 strike-a-light, 85 arrow tips, and 130 sling stones.

***299. Walkey, R. H.—The Neolithic Settlement at Ramsey.**

"Yn Lioar Manninagh," vol. i., p. 212.

Further excavations have been carried on at the site noted by P. M. C. Kermode [No. **364**, 1890] and pointers, pottery, arrow heads, tattooing flakes, arrow scrapers, notched stones, flake knives, and scrapers found in abundance, with any quantity of worked flints and flint cores.

MIXED.

***300. Woods, H.—Catalogue of the Type Fossils in the Woodwardian Museum, Cambridge.**

Cambridge: 8vo. University Press, pp. xvi. and 180.

"This catalogue includes, in addition to the types proper, those specimens which have been figured and described as examples of species previously defined," and no distinction in the entries of one or the other kind is made; but the types can be discovered by the author's name being followed by a reference. The entries are not made under the original names, unless these are considered the right ones at the present day, the original ones in other cases occurring in the synonymy and cross references.[1]

The catalogue comprises 17 Incertæ sedis, 37 Plantæ, 22 Porifera, 29 Hydrozoa, 126 Actinozoa, 44 Echinoidea, 11 Asteroidea, 5 Ophiuroidea, 2 Holothuroidea, 57 Crinoidea, 6 Cystoidea, 3 Blastoidea, 13 Vermes, 44 Polyzoa, 144 Brachiopoda, 290 Lamellibranchiata, 277 Gasteropoda, 6 Polyplacophora, 18 Pteropoda, 1 Scaphopod, 112 Cephalopoda, 1 Cirriped, 9 Ostracoda, 24 Phyllocarida, 750 Trilobita, 3 Eurypterida, 2 Isopoda, 34 Decapoda, 75 Pisces, 1 Amphibion, 74 Reptilia, 5 Aves, and 11 Mammalia. Total 1,647 species.[2]

[1] This is acknowledged in the introduction to be undesirable, and it certainly leads to confusion. It should be remembered that present names represent merely ephemeral opinions—while the original names are unalterable facts of history.

[2] To this list there must be added the following at least:—*Ægoceras finitimum*, Blake, Yorksh. Lias, p. 273, pl. vi., fig. 9; *Ægoceras sagittarium*, Blake, Yorksh. Lias, p. 276, pl. vii., fig. 2; *Ægoceras validum*, Simpson, Blake, in Yorksh. Lias, p. 278, pl. vii., fig. 3; *Ægoceras sociale*, Simpson, Blake, in Yorksh. Lias, p. 278, pl. vii., fig. 6; *Ægoceras diversum*, Simpson, Blake, in Yorksh. Lias p. 282, pl. viii., fig. 3

Each has references to the one or more places where the particular specimen is figured, described, or referred to.

An account of the chief collections in the museum is also given. These comprise the Aitken Coll. (Coal-measures and Millstone Grit), Barrande (Palæozoic, Bohemia), Burrows (Carboniferous Limestone), De Stefani (Italian Pliocene), Dover (Skiddaw Slate), Fisher (Eocene, Purbeck), Fletcher (Wenlock Limestone), Forbes-Young (Chalk), Goodman (Tertiary), Hawkins (Lias), Image (Cretaceous), Leckenby (Mesozoic of Yorkshire), Monk (Inferior Oolite), Montagu-Smith (Pliocene and Cretaceous), Münster (Trias, Jura, and Foreign), Porter (Oxford Clay), Strickland (Miscellaneous), Walton (Jurassic).

***301. Platnauer, H. M.—List of Figured Specimens in the York Museum.**

Ann. Rep. Yorkshire Phil. Soc. for 1890.

The same method is adopted here as in No. **300**. The list includes 14 Plants, 9 Porifera, 3 Actinozoa, 18 Echinodermata, 4 Crustacea, 1 Polyzoon, 17 Brachiopoda, 63 Lamellibranchiata, 80 Gasteropoda, 16 Cephalopoda, 60 Pisces, 4 Reptilia, 15 Mammalia = 304.[1]

***302. Newton, E. T.—The Vertebrata of the Pliocene Deposits of Britain.**

Mem. Geol. Survey, pp. 137, with 10 plates.

This consists of a descriptive list of all the Vertebrate species whose occurrence in British Pliocene deposits has been verified. In each case the evidence is given in detail and critically discussed, and unverified statements of occurrence are mentioned only. In the following list *T.* = teeth, *J.* = jaw, *E.* = ear-bones, *V.* = vertebra, *A.* = antler, *S.* = skull, *B.* = other bones; C. nodule bed at the base of the Coralline Crag, R. at the base of the Red Crag, and F. = Forest Bed. * indicates that the species is illustrated in the plates:—

MAMMALIA.

*Felis pardioides, *J.*, R.
*Machærodus sp., *J.*, F.
*Hyena crocuta, *J.*, F.
*——— striata, *J.*, R.
*Canis lupus, *J.*, R. F.
*——— vulpes, *J.*, R. F. ?
*———? primigenius, *T.*, R.
Mustela martes, *J.*, F.
——— putorius?, *J.*, C.
Gulo luscus, *J.*, F.
*Lutra vulgaris, *J.*, F.
*——— dubia, *J.*, R.
*——— Reevei, *T.*, F.
*Ailurus anglicus, *J.*, R.
*Hyænarctos sp., *T.*, R.
*Ursus arvernensis?, *T.*, R.
——— horribilis?, *J.*, F.
——— spelæus, *J.*, *B.*, F.
*Trichechus Huxleyi, *T.*, R. F.
Phoca (Erignathus) barbata, *B.*, F.
*——— Moori, *B.*, R.
Phocanella minor, *B.*, R.
Bison bonasus, *S.B.*, F.
Ovibos moschatus, *S.*, F.
Caprovis Savinii, *S.*, F.

[1] To these should at least be added *Ichthyosaurus crassimanus*, Blake (Owen, MS.), Yorks. Lias, pl. i., fig. 9 (fore-arm), *Gyrosteus mirabilis*, Ag.; Yorks. Lias, pl. ii., figs. 2, 3 (bones).

*Antilope sp., *T.*, R.
*Gazella anglica, *S.* Norwich, C.
*Cervulus (Cervus) dicranoceros, *A.*, R.
*Cervus ardeus, *A.*, Norw.
*——— carnutorum, *A.*, Norw.
——— Dawkinsi, *A.*, F.
*——— elaphus, *A.*, F.
*——— etueriarium, *A.*, F.
*——— Falconeri, *A.*, R., Norw.
——— Fitchii, *A.*, F.
*——— giganteus, *A.*, R ?
*——— polignacus, *A.*, F.
*——— rectus, *A.*, F.
——— Savinii, *A.*, F.
——— Sedgwickii, *A.*, F.
*——— suttonensis, *A.*, R.
*——— tetraceros, *A.*, F.
——— verticornis, *A.*, F.
Alces latifrons, *A.*, F.
Capreolus caprea, *A.*, F.
Xiphodon platyceps, *S.*, C ?.
Hippopotamus amphibius, *J.*, F.
*Sus antiquus, *T.*, R.
*—— palæochærus, *T.*, R.
—— scrofa, *J.*, F.
Equus caballus, *T.*, R. F.
—— stenonis, *T.*, F.
*Hipparion gracile, *T.*, R.
*Rhinoceros incisivus, *T.*, R.
*———— Schleiermacheri, *T.*, R.
———— etruscus, *T.*, F.
———— megarhinus, *T.*, F.
*Tapirus arvernensis, *T.*, R.
*Hyracotherium leporinum, *T.*, Derived.
*Coryphodon sp., *T.*, Derived.
Mastodon arvernensis, *T.*, R.
———— longirostris, *T.*, C.R.
———— Borsoni, *T.*, R.
Elephas meridionalis, *T.*, R.F.
——— antiquus, *T.*, F.
——— primigenius ?, *T.*, F.
*Halitherium Canhami, *S.B.*, R.
Sciurus vulgaris ?, *B.*, F.
*Castor fiber, *T.B.*, R.F.
*——— veterior, *T.*, R.
*Balæna biscayensis, *V.*, *E.*, F.
*——— affinis, *E.*, R.
*——— primigenia, *E.*, R.
*———(Balænotus) insignis, *E.*, R.
*——— (Balænula) balænopsis, *E.*, *V.*, R.C.
*Megaptera affinis, *E.*, C.R.
———— (Burtinopsis) similis, *B.*, R.
*———— (B.) minuta, *E.*, C.R.
Balænoptera definita, *E.*, R.
———— (Plesiocetus) Goropi, *E.*, R.
Balænoptera borealina, *E.*, R.
*———— emarginata, *E.*, R.
———— sp., *V.*, F.
Cetotherium (Plesiocetus) Brialmonti, *E.*, R.
———— (P.) dubium, *E.*, R.
———— (P.) Hupschii, *V.*, R.
————(Heterocetus) brevifrons, *V.*, *E.* ?, R.
*Herpetocetus scaldiensis, *J.*, *E.*, R.
*Physeter macrocephalus, *T.*, F.
*Eucetus amblyodon, *T.*, R.
*Balænodon physaloides, *T.*, R.
Physeterula Dubusii, *T.*, R.
Physodon grandis, *T.*, R.
———— fusiformis, *T.*, R.
Hoplocetus crassidens, *T.*, R.
———— borgerhoutensis ?, *T.*, R.
———— curvidens, *T.*, R.
*Hyperoodon, sp., *B.*, R.
*Choneziphius planirostris, *S.*, *V.*, R.C.
———— planus, *S.*, R.
———— Packardi, *S.*, R.
*Mesoplodon longirostris, *S.*, R.
———— tenuirostris, *S.*, R.
———— gibbus, *S.*, R.
———— angustus, *S.*, R.
———— angulatus, *S.*, R.
———— compressus, *S.*, R.
———— floris, *S.*, R.
———— scaphoides, *S.*, R.
*Squalodon antwerpiensis, *T.*, R.
Orca citoniensis, *T.*, *B.*, R.
—— gladiator, *V.T.*, F.
Pseudorca crassidens, *V.*, F.
Globiocephalus uncidens, *T.*, *B.*, R.
Monodon monoceros, *T.*, R.F.
Delphinapterus leucas, *V.*, R.
Delphinus delphis, *V.*, F.
*Tursiops (Delphinus) tursio, *V.*, F.
*Trogontherium minus, *J.*, R.
Mus sylvaticus, *J.*, *B.*, F.
Microtus (Arvicola) amphibius, *T.*, F.
——— (A.) arvalis, *T.*, B., F.
——— (A.) gregalis, *T.*, F.
——— (A.) glareolus, *T.*, F.
——— (A.) intermedius, *T.*, F.
Lepus sp., *T.*, R.
Talpa europæa, *J.* ?, F.
Sorex vulgaris, *J.*, *B.*, F.
—— pygmæus, *J.*, *B.*, F.
Myogale moschata, *J.*, *B.*, F.

Trogontherium Cuvieri, *T.*, *S.*, *B.*, F.

Phocæna communis, *V.*, F.

AVES.

*Bubo ignavus, *B.*, F.
*Phalacrocorax carbo, *B.*, F.
Anser sp., *B.*, F.
Anas sp., *B.*, F.
*Spatula clypeata, *B.*, F.
*Uria troile, *B.*, Chillesford C.
Mergulus sp., *B.*
*Diomedea sp., *B.*, R.C.

REPTILIA.

Tropidonotus natrix, *V.*, F.
Pelias berus, *V.*, F.

AMPHIBIA.

Rana temporaria, *B.*, F.
—— esculenta, *B.*, F.
Bufo sp., *B.*, F.
Triton cristatus, *B.*, F.

PISCES.

Perca fluviatilis, *B.*, F.
Acerina vulgaris, *E.*, F.
*Chrysophrys sp., *T.*, R.C., Norw.
Platax Woodwardi, *V.*, *B.*, F.
Thynnus scaldiensis, *V.*, C., F.
*—— thynnus, *V.*, F.
*Anarrhichas lupus, *T.*, C.
Labrus sp., *B.*, R.
Phyllodus sp., *T.*, Derived.
Pleuronectes sp., *J.*, F.
*Gadus morrhua, *J.B.*, F.
*—— pseudæglifinus (sp. nov.), *E.*, C. R., Norw.
*—— luscus, *E.*, C.
*—— minutus, E., C.
—— merlangus, *E.*, C.
*—— virens, *E.*, C.
*—— pollachius, *E.*, C.
*—— elegans, *E.*, C.
*Arius sp., *B.*, R.
Barbus vulgaris ?, *T.*, F.
Leuciscus rutilis, *T.*, F.
—— cephalus, *T.*, F.
—— erythrophthalmus, *T.*, F.
Tinca vulgaris, *T.*, F.
Abramis brama, *T.*, F.
Esox lucius ?, *B.*, F.
Pycnodus sp., *T.*, R., Derived.
Gyrodus sp., *T.*, R., Derived.
Pisodus sp., *T.*, R., Derived.
Lepidotus sp., *T.*, R., Derived.
Accipenser sp., *B.*, R.
Edaphodon, *J.*, R., Derived.
Elasmodus Hunteri, *J.*, R., Derived.
Cælorhynchus, *B.*, R., Derived.
*Galeus canis, *T.*, F.
—— sp., *T.*, R.
*Cetorhinus maximus, *B.*, R.
*Carcharodon megalodon, *T.*, R.C.
*—— Rondeleti, *T.*, R. C.
Lamna (Otodus) obliqua, R., Derived.
*Oxyrhina hastalis, *T.*, R. C.
*Odontaspis (Lamna) elegans, *T.*, R.
*—— (L.) contortidens, *T.*, R.
*Notidanus gigas, *T.*, R.
Myliobatis Dixoni, *J.*, R., Derived.
—— toliapica, *J.*, R., Derived.
—— ? tumidus, *J.*, R.
Ætobatis sp., *T.*, R., Derived.
Rhinoptera Woodwardi, *T.*, Norw.
Ptychodus polygyrus, *T.*, R., Derived.
Raja clavata, *T.*, Weybourne.
—— batis, *T.*, Weyb.
*—— sp., *B.*, R.
Pristis sp., *T.*, R., Derived.
*Squatina sp., *T.*, R.
Acanthias vulgaris, *T.*, Weyb.

The new species, *Gadus pseudæglifinus*, is represented by an otolith more elongated, more pointed at the hinder end, and often more strongly crenulated than that of the Haddock [fig. 19].

The total number of definite Crag species is 142. Only 8·8 per cent. of all the Red Crag nodule-bed species are living, but 69·2 per cent. of those of the Forest Bed; nevertheless, in detail, the latter bed is more linked to those below than to the Pleistocene.

***303. Lydekker, R.—Catalogue of the Fossil Mammals, Birds, Reptiles, and Amphibians in the Science and Art Museum, Dublin.**

Dublin: 8vo, pp. 61.

The specimens are catalogued zoologically, and come from all parts of the world; a large number of them are casts. The principal Irish sources are:—1. Ballynamintra Cave, co. Waterford. 2. Shandon Cave, co. Waterford. 3. Bogs, Crannoges, &c. 4. Kilkenny coal-field. The following are the specimens from these sources:—

Erinaceus Europæus (1).
Canis lupus (1), (2).
—— vulpes (1), (2).
—— domesticus var. Hibernicus (3).
Ursus arctus (1), (2), (3).
Mustela martes (1).
Meles taxus (1).
Lepus variabilis (2).
—— cuniculus (1).
Ovis aries (3).
Capra hircus (1), (3).
Rangifer tarandus (2), (3).
Cervus giganteus (1), (3).
—— elaphus (1), (2), (3).
Sus scrofa (1), (3).
Equus caballus (1), (2).
Elephas primigenius (2).
Corvus corax (2).
Anser segetum (2).
Bernicla leucopsis (2).
Somateria mollissima (2).
Tetrao tetrix (1).
Lagopus mutus (1), (2).
Fulica atra (1).
Colymbus septentrionalis (2).
Loxomma Allmani (4).
Anthracosaurus Russelli (4).
Ichthyerpetum Bradleyæ (4).
Urocordylus Wandesfordi (4).
Ceraterpetum Galvani (4).
Lepterpetum Dobbsi (4).
Dolichosoma Emersoni (4).
—— Huxleyi (sp. nov.), much larger than the last, 20 in. long (4).
Ophiderpetum Brownriggi (4).

***303a. Woodward, A. S., and Sherborn, C. D.—A Catalogue of British Fossil Vertebrata. Supplement for 1890.**

Geol. Mag., n.s., Dec. 3, vol. viii., p. 25.

The list here given records new literature on 161 kinds of fishes, of which 29 are new species; on 14 amphibia, of which 1 is a new species; on 49 reptiles, of which 3 are new species; and on 30 mammals, on which 4 are new species. [The descriptions of the new species will be found noticed in the present volume, or in that for 1890, according to the actual date of the publication.]

MAMMALS.

***304. Flower, W. H., and Lydekker, R.—An Introduction to the Study of Mammals Living and Extinct.**

London: Macmillan, 8vo, pp. 763.

Mammals are considered to have been derived from Amphibia. They are arranged in three sub-classes (after Huxley): PROTOTHERIA, METATHERIA and EUTHERIA.

The PROTOTHERIA include the Mesozoic forms called *Multituberculata*, divided into three families, the *Plagiaulacidæ*, *Polymastodontidæ*, and *Tritylodontidæ*. Amongst this group are ranged *Plagiaulax*, *Microlestes* and *Stereognathus*. The group is characterised by its peculiar incisors, and the absence of canines; they are not an ancestral type. The remaining British Mesozoic Mammals, except *Spalacotherium*, are Polypriodont.

The METATHERIA (= *Marsupialia*) are divided into Polypriodonts and Diprotodonts. The former contain the extinct families *Dromatheriidæ*, *Amphitheriidæ*, *Spalacotheriidæ*, and *Triconodontidæ*, [misprinted *Tritylodontidæ*, see Geol. Mag., 1891, p. 479]. The latter contain the *Diprotodontidæ* and the *Nototheriidæ*, each represented by a single genus.

The EUTHERIA are classed in the following orders: *Edentata*, including the extinct *Megatheriidæ*, and *Glyptodontidæ*; *Sirenia*, with extinct *Rhytinidæ* and *Halitheriidæ*; *Cetacea* with extinct suborder *Archæocete*, represented by the *Zeuglodontidæ*; *Ungulata*. Amongst the *Artiodactyla*, the families *Chæropotamidæ*, *Anthracotheriidæ*, *Merycopotamidæ*, *Cotylopidæ*, *Anoplotheriidæ* and *Dichodontidæ* are called annectant types between bunodont and selenodont types (*Cotylops* is a new name for *Oreodon* because *Orodus* is preoccupied.)

The *Tylopoda* contain the extinct family *Poebrotheriidæ*, which are regarded as the American ancestors of the true camels

The *Perissodactyla* contain the extinct *Lophiodontidæ*, *Palæotheriidæ*, *Lambdotheriidæ*, *Chalicotheriidæ*, *Titanotheriidæ*, *Macrauchenidæ*, and *Proterotheriidæ*. Then follow three extinct sub-orders, *Toxodontia*, comprising the *Toxodontidæ* and *Typotheriidæ*, which seem to form a passage between Ungulates and Rodents; *Condylarthra*, comprising the *Periptychidæ*, *Phenacodontidæ*, and *Meniscotheriidæ*, with carnivorous affinities; *Amblypoda*, comprising the *Pantolambdidæ*, *Coryphodontidæ*, and *Uintatheriidæ*. The *Proboscidea* contain the extinct family *Dinotheriidæ*. *Tillodontia* (called a "group" in one place and sub-order in another) comprise the *Anchippodontidæ* and *Calamodontidæ*, and combine the characters of the Ungulates, Rodents, and Carnivores. The order *Rodentia* contains the extinct *Ischyromyidæ*, *Theridomyidæ* and *Castoridæ* (the first simply mentioned). The *Carnivora* contain the extinct suborder *Creodonta*, comprising the *Hyænodontidæ*, *Proviverridæ*, *Arctocyonidæ*, and *Mesonychidæ*. They show possibly some genetic affinities with marsupials, and also may be the ancestors of the insectivores. The *Primates* contain the extinct family *Hyopsodontidæ*, of the sub-order *Lemuroidea*. Besides the extinct families, a large number of extinct genera belonging to existing families are noticed or described.

***305. Woodward, A. S.—On a Mammalian Tooth from the Wealden Formation of Hastings.**

Proc. Zool. Soc. for 1891, p. 585.

This tooth was found by **C. Dawson** in a lenticular bone bed in the Wadhurst Clay at Hastings, and represents the first European cretaceous mammal. The low enamelled crown is supported by two robust roots, only one side seen, of nearly equal size and depth and terminating obtusely. The coronal surface is half as wide at one end as at the other; it has a large obtuse elevation on one side, and the other side has an elevated, once crenulated rim—but the surface is much worn [fig. 7]. This surface closely resembles that of *Plagiaulax*, but differs specifically in shape and size. It is therefore called, provisionally, *P. Dawsoni*.

***306. Gunn, John.—The Fossil Mammalia of the Cromer Forest Bed, and Associated Strata.**

"Memorials of John Gunn." Norwich: 8vo, pp. 67, with 12 plates (edited by H. B. Woodward).

Consists of notes on the discovery and naming of the various specimens figured in the plates. These are confined to the Proboscidea and Cervidæ, and include :—

Mastodon arvernensis.		Cervus polignacus.
Elephas antiquus,	teeth	——— verticornis.
——— meridionalis	,,	——— Sedgwickii.
——— primigenius	,,	——— Savinii.
——— spp. tusks.		——— Fitchii (Gunn MS.).
Alces bovides (Gunn MS.).		(All represented by antlers.)

***307. Newton, E. T.—On a Skull of *Trogontherium Cuvieri* from the Forest Bed of East Runton, near Cromer.**

Proc. Z. S. for 1891, p. 247. (Published in full in Transactions, 1892.)

Hitherto no British skull has been found, but the present specimen is seen to be identical with Fischer's *Trogontherium*, as Owen believed it would be. There is also no difference between this and *Conodontes Boisvillettii*, Laugel.

***308. Woodward, A. S.—Note on the Occurrence of the Saija Antelope in the Pleistocene Deposits of the Thames Valley.**

Proc. Zool. Soc. for 1890, p. 613.

The fossil consists of the two horn cores and the frontlet, the former with the characteristic ridges and grooves [fig. 5]. It agrees entirely with recent specimens of *Saija tatarica*, except in the comparatively erect position of the horns, in which it agrees with the French Pleistocene specimens. It was discovered by Dr. J. R. Leeson in a loam, not 6 ft. above the Thames in Orleans Road, Twickenham. It is the first representative of the genus in Britain.

309. Young, J. (Professor).—On Mammalian Remains from Cresswell Crag Bone Caves.

Trans. Geol. Soc., Glasgow, vol. ix., pt. i., p. 210.

This expresses the opinion that the River Drift men, and the Cave men were contemporary, as it is not probable that advance in civilisation would be in abeyance in temperate climates for a long period.

BIRDS.

***310. Lydekker, R.—Catalogue of Fossil Birds in the British Museum (Natural History).**

London: Eyre & Spottiswoode, 8vo, pp. 364.

In this catalogue, besides the birds represented by specimens in the British Museum, the names of all recorded European fossil birds, except Passeres and Picariæ are given [but not included in the present summary. British birds in italics, V. = vertebræ, L. = long bones; Foreign birds, names only.]

Order CARINATÆ.

PASSERES.—Corvus corax; *C. corone*, L., Superficial Norfolk; *Pyrohocorax graculus*, L., Kirkdale; Heteraloctra australis.

PICARIÆ.—No names.

PSITTACI.—Stringops habroptilus; Nestor meridionalis; Conurus.

STRIGÆ.—Strix melitensis (sp. nov.), femur slightly longer and more slender than in S. flammea. *Bubo ignavus*, L., Forest Bed; Cetupa ceylonensis; *Nyctea scandiaca*, L., Kent's Cavern.

ACCIPITRES.—Circus Gouldi; *Buteo vulgaris*, L. and pelvis, Brixham Cave; *Palæocircus Cuvieri*, L., Eoc. Hordwell; *Haliaëtus pelagicus*, L., Superficial Walthamstow; H. albicilla; Aquila chrysaetus; Harpagornis Moorei; Gyps melitensis; Vultur monachus; Gypagus papa; *Lithornis vulturinus*, various, Eoc., Sheppey.

STEGANOPODES.—Pelecanus Cautleyi; P. sivalensis; P. intermedius, P. Fraasi (sp. nov.), skull wider than the last, occipital and parietal planes forming a more open angle, occipital fossa Λ-shaped, and a sharp ridge on the supra-occipital, Bavaria; Sula piscator; Pelagornis miocænus; *Argillornis longipennis*, skull, L., Eoc., Sheppey; *Phalacrocorax carbo*, Pleist. Grays.; P. miocænus; *Actiornis* (gen. nov.), proximal end of ulna like that of *Phalacrocorax*, but differs in the form of the articular cavities, and in the less depth of the fossa for the brachialis anticus; *A. anglicus* (sp. nov.), as above, smaller than P. carbo., L., Eoc., Hordwell [fig. 8.]; *Odontopteryx toliapica*, skull, L., Eoc., Sheppey.

HERODIONES.—*Proherodius* (gen. nov.), allied to Ardea, but the coracoidal grooves of the sternum descending further down at the sides, and a tubercle on the ventral surface of the anterior border. Tarso-metatarsus without closed channels in the talon, and the trochleæ unequal. *P. Owenii* (sp. nov.), as above, size of A. purpurea, sternum, L., Eoc., London [fig. 9]; Leptoptilus Falconeri; Palæociconia australis; Propelargus (gen. nov.), distal end of tarso-metatarsus more suddenly expanded, and with a flatter curve of the trochleæ than in Ciconia; P. cayluxensis (sp. nov.), Eoc., Lot (figured); Pelargopsis magna; Amphipelargus (gen. nov.), distal end of tibio-tarsus, between that in Gruidæ and Ciconiidæ; A. major (sp. nov.), Pliocene, Samos; Pseudotantalus leucocephalus; Ibis pagana, Ibidopodia palustris; *Ibidopsis* (gen. nov.), distal end of tibio-tarsus narrower than usual in Ibis, and the proximal cnemial crest less deep, cranial rostrum narrower and less deflected. *I. hordwellensis* (sp. nov.), of the size of I. rubra, L. cranium, Eoc., Hordwell [fig. 10].

ODONTOGLOSSÆ.—Phenicopterus Croizeti; *Elornis? anglicus* (sp. nov.), humerus of size of the bone in Palælodus gracilis, and smaller than that in E. littoralis, Eoc., Hordwell [fig. 11]; Palælodus crassipes; P. ambiguus; P. gracilipes; P. minutus; *Agnopterus? hantoniensis* (sp. nov.), genus has a longer coracoid, with smaller sub-clavicular process, and less oblique sternal border, and the femur has a longer neck than in Phænicopterus —no reason for distinguishing this from A. laurillardi, coracoid and femur, Eoc., Hordwell [fig. 12].

ANSERES.—Chenalopex pugil; Cnemiornis calcitrans; *Anser cinereus*, L., Pleistocene, Grays; *A. segetum*, L., Kent's Hole. A. æningensis; *Bernicla brenta*, L., Superficial, Walthamstow, and Kirkdale; B. jubata; *Cygnus musicus*, L., Pleistocene, Grays, &c.; *C. Bewicki*, L., Peat, Newport, Mon.; C. Falconeri; Tadorna variegata; *T. sp.*, Brixham Cave; *Anas boscas*; L., Pleistocene, Essex, Norfolk; A. Meyeri; A. robusta; A. Blanchardi; *Fuligula ferina*, L., Forest Bed, Norfolk; F. novæ-zealandiæ; F. arvernensis (sp. nov.), humerus more slender than in A. Blanchardi.

COLUMBÆ.—*Columba livia*, L., Peat, Newport, Mon.; C. melitensis (sp. nov.), coracoid with smaller and narrower head, &c., Pleistocene, Malta (figured); Turtur communis; Carpophaga novæ-zealandiæ; Pezophaps solitaria; Didus ineptus.

GALLINÆ *Tetrao tetrix*—L., Kent's Hole, Peat, Newport Mon.; *T. urogallus*, L., Forest Bed; Lagopus albus; L. mutus; Francolinus pictus; Coturnix novæ-zealandiæ; Palæortyx Blanchardi; P. gallica; P. cayluxensis (sp. nov.), small, from phosphorites; Phasianus altus; Talegalla Lathami.

FULICARIÆ.—Ocydromus Earli; Aptornis otidiformis; A. defossor; Notornis Mantelli; Gypsornis Cuvieri.

Alectorides.—Grus melitensis; G. excelsa; *G. hordwellensis* (sp. nov.), tibio-tarsus only, smaller than in the living G. virgo, L., Eoc., Hordwell [fig. 13]; *Geranopsis* (gen. nov.) coracoid only known, narrower than in Grus, with shorter and less oblique head, a less reflected subclavicular process, and a deeper scapular fossa. *G. Hastingsiæ* (sp. nov.), size of I. pagana. Eoc., Hordwell [fig. 14]. Otis affinis (sp. nov.), smaller than O. undulata, Miocene, Bavaria.

Limicolæ.—Milnea (gen. nov.), humerus like that in Ædicnemus, but no ridge on dorsal side, deeper and bifid depression for brachialis anticus. M. gracilis. (sp. nov.), size of Æ. Scolopax, Mioc., France; Tringa gracilis; Totanus Lartetianus; Elornis paludicola.

Gaviæ.—Larus elegans; L. titanoides; *Halcyornis toliapicus*; Ægialornis (gen. nov.), humerus short, stout, with long delto-pectoral crest, deep coraco-humeral groove, &c. Æg. gallicus, sp. nov., phosphorites (figured).

Tubinares.—Ossifraga gigantea; Diomedea chlororhyncha; *D. anglica* (sp. nov.), L., smaller than D. exulans, with a more slender tibio-tarsus, figured in Q.J.G.S., vol. xlii., p. 366.

Pygopodes.—*Colymbus septentrionalis*, Pleistocene, Mundesley; *Colymboides anglicus* (sp. nov.), L., coracoid more than half the size of that in the last. Eoc., Hordwell [fig. 15]. Alca impennis.

Impennes.—Eudyptes antipodum; E. chrysocomus.

Odontonithes.—None.

Odontolcæ.—*Enaliornis Barretti*, Cambridge Greensand; Hesperornis regalis (casts); H. crassipes (cast).

Order RATITÆ.—Struthio asiaticus; Æpyornis maximus; Æ. medius; Apteryx australis; A. Mantelli; A. Haasti; A. Oweni; Pseudapteryx (gen. nov.); Tarsometatarsus with outer foramen much lower than inner one, no foramen between 3rd and 4th trochleæ, &c. P. gracilis (sp. nov.), size of A. Oweni, Superficial, New Zealand; Dinornis novæ-zealandiæ; D. maximus; D. struthioides; D. gracilis; Megalapteryx tenuipes (sp. nov.), tibio-tarsus, longer and more slender than in type, &c., viz., M. Hectori; Anomalopteryx casuarina; A. dromæoides; A. didiformis; A. didina; A. parva; A. Oweni; A. curta; A. geranoides; Emeus gravipes (nom. nov. = Dinornis gravis, Owen, Trans. Zool. Soc., vol. viii., p. 361, 1872, Nov., 1870); E. crassus; Pachyornis (gen. nov.) = Palapteryx, Haast, non. Owen, skull, sternum, tibio-tarsus, tarso-metatarsus, femur, vertebral column described at length. P. elephantopus; P immanis (sp. nov.), tarso-metatarsus larger than in the last, shaft wider and more flattened, skull more depressed, Superficial, New Zealand. [The bones of the Dinornithidæ are very

numerously represented]. Dromæus patricius; Hypsilornis (gen. nov.), second phalangeal of third digit stouter, &c., than in Casuarius. H. sivalensis (sp. nov.), of the size of C. emeu, Plioc., Siwalik; Dromornis australis; Gastrornis parisiensis (cast); *G. Klaasseni* (casts); *Dasornis londinensis*.

Order III., SAURURÆ.—Archæopteryx lithographica.

311. Brodie, P. B.—On Fossil and Recent Extinct Birds, with an Account of the Formations in which they Occur, and the Circumstances of their Preservation.

Proc. Warwickshire Nat. and Arch. Field Club for 1890, p. 11.

A brief general summary of our knowledge on the subject.

REPTILES.

***312. Lydekker, R.—On a New Species of *Trionyx* from the Miocene of Malta, and a Chelonian Scapula from the London Clay.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 37.

The British scapula is represented by three fragments from Sheppey, comprising the glenoidal portion of the bone, the distal extremity of the true scapular bar, and a considerable portion of the precoracoidal bar. The transverse diameter of the scapular neck is over 6·7 in., which is much larger than that of *Eosphargis gigas*. Nevertheless, as this is the only turtle from these deposits to which it can be referred, the author considers it an *Eosphargis*, and therefore belonging to the *Dermochelyidæ*. As, however, it has more resemblance to the scapula of a *Chelone*, he agrees with Dr. Baur that the *Athecata* are a specialised offshoot from the earlier *Chelonidæ*, a view which he had previously rejected.

***313. Woodward, A. S.—*Pseudotrionyx* from the Bracklesham Beds.**

Geol. Mag., Dec. 3, vol. viii., p. 546.

The presence of this Chelonian is indicated by one of the middle marginal bones, showing the pit for the reception of the rib, and covered with coarse but faintly-marked pits. It agrees in size, &c., with *P. Delheidi*, Dollo.

***314. Boulenger, G. A.—On some Chelonian Remains Preserved in the Museum of the Royal College of Surgeons.**

Proc. Zool. Soc. for 1891, p. 4.

The second is a skull of *Trionyx* from the Upper Eocene of Hordwell, where no such skulls have hitherto been found. This so closely resembles the skull of the recent Indian *T. hurum*, that had the fossil been found in the Pleistocene of

India he would have unhesitatingly pronounced it to belong to that species. As it is, as the shells of *T. planus*, Ow., most nearly resemble in sculpture those of *T. hurum*, it may stand under the former of these names. The third is a bone from the London Clay, Sheppey, which Owen described as "the lower or distal end of the tympanic bone of the *Crocodilus toliapicus*," but which the author says is the proximal end of the left humerus of *Eosphargis gigas*, Ow. He notes also that the British Eocene and Oligocene crocodilian forms should all be referred to *Diplocynodon*, and that the fossils described by Owen as portions of the left and right ramus of the lower jaw of the same *Crocodilus toliapicus* are respectively the scapula of *Eosphargis*, and part of a Lias Plesiosaur.

***315. Seeley, H. G.—On *Saurodesmus Robertsoni* (Seeley), a Crocodilian Reptile from the Rhætic of Linksfield in Elgin.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 166.

The subject of this paper is a limb-bone found in a mass of shale now determined to be a Rhætic Boulder in drift. About 50 years ago it was called by Owen a "chelonian femur," and said to resemble the bone in Trionyx, and it has lately been catalogued by Lydekker as a "right humerus or femur of a chelonian." The author cannot agree that it is either a femur or chelonian. "The bone is, he submits, a right humerus."[1] The general form is chelonian; but it differs in having a cellular medullary cavity, in its straight shaft, in the open concave curve between the radial and ulnar crests, in the distinctness and shortness of the radial crest, in the slight development of the ulnar crest, with its roughness and convexity; in the thickness of the ridge between the shaft and head; in the divergence of the ventral ridges; in the great transverse extent of the distal end, with a sharp edge on the radial side. It does not resemble the humerus of a crocodile, but its affinities appear to be with the Crocodilia, in the knife-like edge of the radial process, in the prolongation of the shaft beyond the radial process, in the plan of the distal articulation, and in the hollowness of the shaft. It thus indicates a primitive Crocodilian stock, with a tendency towards a generalised Lacertian type.

***316. Boulenger, G. A.—On British Remains of *Homœosaurus*, with Remarks on the Classification of the Rhynchocephalia.**

Proc. Zool. Soc. for 1891, p. 167.

A small Rhynchocephalian mandible in the College of Surgeons is thought to come from the Forest Marble of Cor-

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[1] The author has now some new evidence which will lead him to modify this interpretation.

sham, and one like it occurs in the Purbeck of Swanage. It differs from *Homœosaurus Maximiliani*, Meyer, in being ⅓ larger, so he calls it *H. major* [fig. 6]. He is not satisfied with the arrangement of the Rhynchocephalians by Lydekker or Zittel, and proposes the following instead.

Rhynchocephalia ...	Proterosauria.. ..	Palæohatteriidæ. Proterosauridæ.
	Rhynchocephalia vera	Hatteriidæ. Homœosauridæ. Rhynchosauridæ. Champsosauridæ.

***317. Seeley, H. G.—The Ornithosaurian Pelvis.** Ann. Nat. Hist., ser. vi., vol. vii., p. 237.

The structure of the pelvis is characteristic of orders in the Reptilia, but in the case of the Ornithosauria, there are differences of interpretation. The author asserts the existence of a pair of prepubic bones, as a fourth element of the pelvis. The first question is as to whether 3 or 2 bones enter into the formation of the acetabulum. In a specimen of *Ornithocheirus* at Cambridge, and in one of *Pterodactylus Suevicus* [called *Cycnorhamphus Fraasi* further on, and figured as such] at Stuttgart, the three bones are seen suturally joined, and, therefore, other specimens in which the suture is obliterated can have no weight. The separate prepubic bone is not a fractured portion of the pubis (for which no evidence has been brought forward) for the ventral end is not a fractured surface.

Nor is the bone ever seen blended with the pubis. On the positive side he can only state that "there is in a few examples some evidence in favour of articulation at its ventral end." Quenstedt, in his specimen, found a tubercle placed towards the ilium, which he thought was for the articulation—but the author cannot confirm this, and thinks the tubercle pathological. The forms and usual positions of these bones are in favour of their separate origin. Details of the pelvis are then given in *Pterodactylus grandipelvis*, Von Meyer, in which the anterior part of the pelvis is more widely separated than the hinder, so that the pubic bones could not have met ventrally unless, as is never the case, they were longer than the ischia; in *Pt. dubius*, v. Meyer, where the prepubic bones are shoulder of mutton shaped [as figured]; in *Cycnorhamphus Fraasi*, in which all four bones are distinctly seen—the ischium with a straight ventral border as if for a median symphysis and the pubes too short to meet, but with a thickened anterior ventral end corresponding in size to the stalk of the hatchet-shaped prepubis. Similarly shaped prepubic bones, including fan-shaped, are met with in *Pterodactylus longirostris*, *Pt. micronyx*, *Pt. rhamphastinus*, *Pt. Kochi*, and *Pt. medius*.

In the *Rhamphorhynchidæ*, the prepubic bones are Y-shaped. In *Rh. Munsteri*, they become like a boomerang, and in one specimen, called *Rh. Gemmingii*, they unite into a bow-shaped bone.

In *Dimorphodon macronyx* the ilium, ischium, and pubis make a single bone, and there are two separate prepubic bones; they are curved and expanded at the (broken) distal ends with a longitudinal ridge and a swelling proximally, as if for an articulation.

Restorations are then given of the ventral aspect of the pelvis in *Cycnorhamphus Fraasi* and *Dimorphodon macronyx* [figs. 16, 17]. He compares with these his reading of the Crocodile pelvis, in which he makes the usually called pubic bones prepubes, and reduces the true pubics to a mere process on the ischium. In this connection he gives a theoretical restoration of the ventral aspect of the pelvis of Iguanodon, taking two bones found further forward in the skeleton, and variously regarded as clavicles or sternal bones, to be really prepubes, and represents them as articulated to the pubes, though the latter are thin-edged and the former have thickened articular ends. He gives the following as his classification of the sub-class Ornithosauria:—

Order 1—Ornithocheiroidea.
Fam. Ornithocheiridæ.
Fam. Pteranodontidæ.
Sub-order 2—Pterodactylia.
Fam. Pterodactylidæ.
Order 3—Pterodermata.
Fam. Dimorphodontidæ.
Fam. Rhamphorhynchidæ.

***318. Seeley, H. G.—On the Shoulder Girdle in Cretaceous Ornithosauria.**

Ann. Nat. Hist., ser. vi., vol. vii., p. 438.

Some symmetrical bones from the Cambridge Greensand had been considered possibly frontals or vomers, or parts of the neural spine of one of the sacral vertebræ. The discovery by Professor Marsh, that in certain American Cretaceous Ornithosaurs, some of the thoracic vertebræ were united to form a kind of sacrum to which the scapula was articulated, has suggested that these bones may be part of this structure. Traces of two sutures can be seen, which indicate three vertebræ, on the united neural spine are seen transversely oval facets, concave from front to back, which may have been for the scapular articulation. The Ornithocheiran scapula is also thickened at the end, so as to exactly correspond with this facet. On this hypothesis, the author gives restorations of the pectoral vertebræ and of the shoulder girdle.

He then proceeds to confirm this view by drawing attention to several points in which the close affinity between English and American Cretaceous Ornithosaurs has been shown. A bone which had been taken by Owen for part of a metacarpal, he recognised, in 1871, as part of the premaxillary of a toothless Pterodactyle, which he named *Ornithostoma*, and in 1884 a similar jaw was found in America, and named *Pteranodon*, which should give way to *Ornithostoma*, the species of which he now names *O. Sedgwickii*. He also figured an Ornithosaurian quadrato-jugal of the same type as now found in the American *Pteranodon*, and there is reason to believe that, as in the latter, there was a strong occipital crest to the skull, and an absence of any antorbital vacuity. The peculiar structure also of the carpus in *Ornithocheirus* is now paralleled in the toothless Ornithosaurs from Kansas. Whether or not the specimens showing these structures were toothless is a matter of secondary importance, as the presence or absence of teeth is not an ordinal character. The whole order *Ornithocheiroidea* is charcteristic of Cretaceous times, and the term *Pterosauria*, if retained at all, must be restricted to forms of which *Pterodactylus* is the type, the whole sub-class being *Ornithosauria*.

***319.—Lydekker, R.—On certain Ornithosaurian and Dinosaurian Remains.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 41, pl. v.

I.—Three bones which the author described as Ornithosaurian ulnar metacarpals, with bony plates for the support of the patagium, Professor Marsh at once identified as quadrates of the right side, the bony plates being part of the anchylosed pterygoid. The smaller may have belonged to *Pterodactylus*, or rather *Rhamphorhynchus Manseli*, and the larger to *R. suprajurensis*.

II.—He refigures, natural size, a cervical vertebra of a Theropodous Dinosaur, which he had named *Calamospondylus Foxi*, but the generic name being pre-occupied, he changes it to *Calamosaurus*.

Professor Marsh has also identified as a right tibia belonging to the *Cæluridæ*, a bone referred by the author to *Hypsilophodon* in his catalogue (the whole of the tibiæ on p. 194 being referred to wrong sides) "on careful examination it is at once seen to have nothing to do with the Iguanodontidæ." Its Theropodous characters are its polished and dense surface, its long, sharp, fibular exterior ridge, its flattened distal end, with an anterior large facet. It may have belonged to a smaller specimen of the *C. Foxi*.

***320. Lydekker, R.—Note on a Nearly Perfect Skeleton of *Ichthyosaurus tenuirostris* from the Lower Lias of Street, Somerset.**

Geol. Mag., Dec. 3, vol. viii., p. 289, pl. ix.

The plate is a figure of a very perfect specimen of the species now in the British Museum, to which it was presented by Mr. Gillett. The text draws attention to the characters of the species, particularly to the small number (4) of digits in the front paddle. *I. longirostris* and *I. latifrons*, it is considered, may be included within this species.

The author also notes that the type of *I. acutirostris* has been shown to have smooth carinated teeth, and it therefore belongs to the genus *Temnodontosaurus*. Hence the other specimens in the B.M. catalogue referred to this must be called by the next name in the synonymy, viz., *I. quadriscissus*.

***321. Seeley, H. G.—On the Neural Arch of the Vertebræ in the Ichthyosauria.**

Rep. Brit. Assoc. for 1890, p. 809.

The neural arch has no zygapophyses, or zygapophysial facets, but there is a single flat median facet of vertically ovate form above the neural canal back and front, which the author calls a protozygapophysis.

AMPHIBIANS.

***322. Woodward, A. S.—On a Microsaurian (*Hylonomus Wildi*, sp. nov.) from the Lancashire Coal-field.**

Geol. Mag., Dec. 3, vol. viii., p. 211.

The fossil is contained in a nodule 0·08m. long in the roof of the Bullion coal at Trawden, near Colne. It shows the mandible with conical teeth; vertebræ well ossified; ribs stout; interclavicle large and rhomboidal, with radiating furrows; ilium as large as femur. The dermal scutes cover the whole trunk, those of the ventral side being larger than those of the dorsal. It agrees with *Hylonomus* of Nova Scotia; but the shape of the mandible and the dermal armour give specific characters. Hence it is named *Hylonomus Wildi*, after its discoverer [fig. 18].

***323. Lydekker, R.—On a Labyrinthodont Skull from the Kilkenny Coal-Measures.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 343.

A specimen in the Science and Art Museum, Dublin, shows both the upper and under side of a cranium, and a left mandibular ramus. The cranium has a parabolic contour 4 in. by 4 in., with circular, widely-separated orbits. It differs from *Erpetocephalus rugosus*, Huxley, in its larger size, its deeper auditory slits, and less outwardly-produced epiotic cornua. As *Erpetocephalus* has been shown to be identical with *Ichthyerpetum*, he calls this *I. hibernicum* [fig. 75].

This genus is not, as he formerly thought, from a damaged specimen, allied to *Nyrania*, but is a member of the *Brachyopina*, which can scarcely be separated from the *Dendrerpetidæ*. The under surface and mandible agree closely with those of *Pholidogaster pisciformis*, and like them it shows pisciform characters. These forms are allied to others which, in the Indian, Australian, and Ethiopian regions, occur at a later date.

FISHES.

*324. Woodward, A. S.—Catalogue of the Fossil Fishes in the British Museum (Natural History), Cromwell Road, S.W. Part II.

London: 8vo, pp., 567, with 16 plates.

Reviewed by **R. H. Traquair** in Geol. Mag., p. 123.

Although this is Part II. and is to be followed by Part III., inasmuch as it covers that part of the class which is most critical in the matter of classification, advantage is here taken to discuss this question. It is no longer possible to retain the two great subdivisions of Günther—the Palæichthyes and the Teleostei; for both these terms, with that of Ganoidei, are now known to possess no precise scientific value. The course of development, at least since Lower Devonian times, has followed two distinct lines, the "autostylic" and the "hyostylic" of Huxley, in which the upper segments of the mandibular and hyoid arches are directly fused with the chondrocranium, or loosely articulated respectively. Each of these groups soon separated into two phyla, characterised by the degree of perfection of the exoskeleton, and, if the evolution of the paired fins be regarded as a criterion, three of these four types (*i.e.*, all except the bony hyostylic group) attained their maximum specialisation before the end of the Palæozoic Epoch. These four types, which are here called sub-classes, are named respectively *Elasmobranchii* and *Teleostomi* (Hyostylic), *Holocephali* and *Dipnoi* (Autostylic). Each of these, so far as known, shows three stages in the evolution of paired fins corresponding closely to ordinal groups. These stages are: 1, Archipterygium, or paddle-like form (elongate or abbreviate); 2, Pectorals di- or tri-basal, pelvics abbreviate; 3, Basal cartilages small or rudimentary. Thus the whole class is represented as follows:—

Hyostylic.	*Autostylic.*
ELASMOBRANCHII.	HOLOCEPHALI.
1. *Ichthyotomi.*	1. (Unknown.)
2. *Selachii.*	*Chimaroidei.*
3. *Acanthodii.*	3. (Unknown.)

TELEOSTOMI.	DIPNOI.
1. *Crossopterygii.* (Pal. and Mes.)	1 *Sirenoidei.*
2. *Crossopterygii.* (Cain.)	2. (Unknown)
3. *Actinopterygii.*	3. *Arthrodira.*

Outside this scheme is the sub-class OSTRACODERMI, which are neither Ascidians (Cope) nor Arachnids (Patten) [*see* No. **404**, 1890].

Of the Hyostylic fishes, the *Ichthyotomi* and *Selachii* were treated of in Part I. The *Acanthodii* were the culminating series of the Elasmobranchs at the time when this sub-class was one of the dominant types. The following is the synopsis of families:

A. One dorsal fin.
  Clavicular bones absent. *Acanthodidæ.*
B. Two dorsal fins.
  Clavicular bones absent. *Ischnacanthidæ.*
  Clavicular bones present. *Diplacanthidæ.*

(R. H. Traquair says the "clavicular bones" equal the "basal cartilages" in the others.)

The species of *Acanthodidæ* are [British ones in italics, * figured] Acanthodes *Bronni, Ag.; A. Rouvillei, Sauvage; A. **Wardi*, Eg.; A. *nitidus* (sp. nov.), larger, and pelvic fins more remote; A. pygmæus, Fritsch; A. concinnus, Whiteaves; A. **pusillus*, Ag.; A. *Peachi*, Eg.; A. **Mitchelli*, Eg.; A. affinis, Whit.; Acanthodopsis *Wardi*, H. and A.; Cheiracanthus *Murchisoni*, Ag.; C. *latus*, Eg.; C. *grandispinus*, M'Coy; To the *Ischnacanthidæ* belongs Ischnacanthus **gracilis*, Eg. (the only genus).

The species of *Diplacanthidæ* are Diplacanthus **striatus*, Ag.; D. **longispinus*, Ag.; Climatius *reticulatus*, Ag.; C. scutiger, Eg.; C. *uncinatus*, Powrie; C. *Macnicoli*, Powrie; C. *grandis*, Powrie; C. *gracilis*, Powrie; C. ? *ornatus*, Ag.: C. ? *latispinosus*, Whit.; Parexus *incurvus*, Ag.; P. **falcatus*, Powrie.

The Autostylic fishes, which are less numerous, are next taken.

Sub-class II., HOLOCEPHALI.— The only order is CHIMÆROIDEI. The following is the synopsis of families:—

I.—Spines unknown, one pair of dental plates above and below. *Ptyctodontidæ.*

II.—Dorsal spines absent. Rostral spine in male. Trunk depressed, snout elongated.
  Two pairs of dental plates above, one pair below. *Squaloraiidæ.*

III.—Spine in front of anterior dorsal fin. Rostral spine in male.
  Few dermal plates on head. Two pairs of dental plates above, one pair and anterior azygos tooth below. *Myriacanthidæ.*
  No dermal plates. Two pairs of dental plates above, one pair below. *Chimæridæ.*

No species of *Ptyctodontidæ* are in the collection. The three genera are: *Ptyctodus, Rhynchodus, and Palæomylus (gen. nov.). The "symphysial surface relatively very broad, tritors punctate, oral surface triturating, with a single

indefinite tritoral area," to include (Rhync.) crassus, frangens and Greenei, of America.

The species of *Squaloraiidæ* are: Squaloraja **polyspondyla*, Ag.; S. *tenuispina*, A.S.W.; Chalcodus, Zitt., not represented.

The species of *Myriacanthidæ* are: Myriacanthus **paradoxus*, Ag.; M. **granulatus*, Ag.; Chimæropsis paradoxa, Zittel (not in B.M.).

The species of *Chimæridæ* are: Ganodus **Oweni*, Ag.; G. **dentatus*, Eg.; G. **rugulosus*, Eg.; Ischyodus **Colei*, Ag.; I. *emarginatus*, Eg.; I. *Egertoni* (Buck.); I. Dufrenoyi, Eg.; I. *Beaumonti*, Eg.; I. *Townsendi* (Buck.); I. Quenstedti, Wagner; I. avitus (Meyer) (not in B.M.); I. *planus*, Newton; I. *Thurmanni*, P. and C.; I. *latus*, Newton (not in B.M.), I.? *incisus*, Newton; Edaphodon *Sedgwicki*, Ag.; E. *Mantelli* (Buck.); E. *Agassizi* (Buck.); E. *crassus*, Newton; E. *Reedi*, Newton; E. *Bucklandi*, Ag.; E. **leptognathus*, Ag.; E.? *laminosus*, Newton; Callorhynchus Hectori, Newton; Elasmodectes *Willetti*, Newton; Elasmodus *Hunteri*, Eg.; E. Greenoughi, Ag.; Chimæra *pliocenica (sp. nov.), a large Tuscan species.

Next are enumerated the Ichthyodorulites, of which the corresponding fish is unknown. The following is the list:—

Onchus *Murchisoni*, Ag.
——— *tenuistriatus*, Ag.
——— quadrisulcatus (Kade).
——— granulatus, Röm.
Ctenacanthus *major*, Ag.
——— *denticulatus*, M'Coy.
——— *brevis*, Ag.
——— *heterogyrus*, M'Coy.
——— *sulcatus* (Ag.).
——— ? *lævis*, Davis.
——— ? *pustulatus*, Davis.
Homacanthus arcuatus, Ag.
——— *microdus*, M'Coy.
Acondylacanthus *attenuatus*, Davis.
——— **Colei*, Davis.
——— *tenuistriatus*, Davis.
——— *distans* (M'Coy).
Asteroptychius *ornatus*, M'Coy.
Cosmacanthus *marginalis*, Davis.
——— *carinatus*, Davis.
——— *priscus* (M'Coy).
Lispacanthus *retrogradus*, Davis.
Lepracanthus **Colei*, Owen.
Nemacanthus *monilifer*, Ag.
——— *brevis*, Ph.
Gnathacanthus *triangularis*, Davis.
——— *striatus*, Davis.
Apateacanthus (gen. nov.) vetustus (Chalke).
Pristacanthus *securis*, Ag.
Cœlorhynchus *rectus*, Ag.
Cœlorhynchus gigas, A. S. W.
——— *cretaceus*, Dixon.
Machæracanthus sulcatus, Newberry.
Haplacanthus marginalis, Ag.
Heteracanthus politus, Newb.
——— *heterogyrus, Ag.
Psammosteus mæandrinus, Ag.
——— *arenatus*, Ag.
——— paradoxus, Ag.
Stethacanthus ———
Physonemus *arcuatus*, M'Coy.
——— *attenuatus*, Davis.
——— *hamatus* (Ag.)
Stichacanthus *Cœmansi*, Kon.
——— *tortworthensis*, Davis.
Oracanthus **Milleri*, Ag.
——— *pustulosus*, Ag.
——— pnigens, M. & W.
Gyracanthus **formosus*, Ag.
Aganacanthus ———
Erismacanthus *Jonesi*, M'Coy.
——— *major* (Davis).
Listracanthus ———
Byssacanthus crenulatus, Ag.
Edestus Heinrichsi, M. & W.
——— *minor, Newb.
——— Davisii, H. Woodward.
Cynopodius **crenulatus*, Traq.
Euctenius **unilateralis* (Barkas).

Cœlolepis ——— Thelodus *parvidens*, Ag.

Sub-class III., OSTRACODERMI; Order I., HETEROSTRACI.—This contains only one family, *Pteraspidæ*. The species are Pteraspis **rostrata* (Ag.). This is found to have a simple ventral shield, called "Scaphaspis," and a restoration [fig. 76] shows their connection. P. *Crouchii*, Lank.; Palæaspis *sericea* (Lank.); P. americana, Claypole; Cyathaspis **Banksi* (H. & S.); C. **Maccullougbi* (sp. nov.) [fig. 77].

Order II., OSTEOSTRACI.—Synopsis of families:—

Surface of shield tuberculated, interorbital fixed. *Cephalaspidæ*.
Surface of shield finely punctate, interorbital loose. *Trematatspidæ*.

The species of *Cephalaspidæ* are Cephalaspis **Lyelli*, Ag.; C. *Salweyi*, Eg.; C. **Powriei*, Lank.; C. **Pagei*, Lank.; C. **Murchisoni*, Eg., of which a restoration is given, from G. H. Piper's specimens [*see* No. **146**, 1890]. The supposed pectoral fins are continuations of the flexible middle layer of the shield, and have the functions of opercula. C. *Lightbodii*, Lank.; C. *campbelltonensis, Whit.; C. Dawsoni, Lank.; C. laticeps, Traq.; ‖Eurkeraspis **pustulifera* (Ag.); Auchenaspis **Salteri*, Eg.; A. **Egertoni*, Lank.; A. verrucosa (Eichw.); Didymaspis **Grindrodi*, Lank.

The family Trematapidæ includes only Trematapis *Schrenki, Pander (not in B.M.).

Order III., ANTIARCHA, contains only the family *Asterolepidæ*. The species are: Asterolepis *ornata, Eichw.; A. concatenata, Eichw.; A. *maxima* (Ag.); Pterichthys **Milleri*, Ag.; P. *testudinarius*, Ag.; P. **productus*, Ag.; P. **oblongus*, Ag.; P. rhenanus, Beyrich (not in B.M.); Microbrachium ——, Bothriolepis ornata, Eichw.; B. Panderi, Lahusen; B. **major*, Ag.; B. *obesa*, Traq.; (not in B.M.), B. *canadensis, Whit.; B. *hydrophila*, Ag.; B. *macrocephala*, Eg.

Here is placed Ceraspis carinata—forming the *Ceraspidæ*.

Sub-class IV., DIPNOI; Order I., SIRENOIDEI.—Synopsis of families:—

A. Cranial roof-bones numerous.
Jugular plates, no marginal teeth. *Dipteridæ*.
Jugular plates, marginal teeth. *Phaneropleuridæ*.
No jugular plates, no marginal teeth. *Ctenodontidæ*.
B. Cranial bones few.
No jugular plates, no marginal teeth. *Lepidosirenidæ*.

The following are the species of *Dipteridæ*: Dipterus *valenciennesi*, S. & M.—a specimen is figured showing lobate paired fins; D. *macropterus*, Traq.; D.? serratus, Eichw.; D.? marginalis, Ag.; D.? radiatus, Eichw.; Palædaphus insignis, van B. and de Kon.; P. devoniensis, v. B.; P. Lesleyi, Newb.; Conchodus ——, Ganorhynchus Woodwardi, Traq.

The species of *Phaneropleuridæ* are: Phaneropleuron

**Andersoni*, Huxley; P. curtum, Whit.; Uronemus *lobatus*, Traq.; U. **splendens*, Traq. (R. H. Traquair objects to this genus being placed here).

The species of *Ctenodontidæ* are: Ctenodus **cristatus*, Ag. (R. H. Traquair notes that the figs. 36, 2 represent the lower and not the upper dental plates, as stated, and are correctly drawn convex). C. *interruptus*, Barkas; C. **Murchisoni*, Ward; Sagenodus **inæqualis*, Owen; S. *quinquecostatus*, Traq. (not in B.M.).

The species of *Lepidosirenidæ* are: Ceratodus *latissimus*, Ag.; C. *parvus*, Ag.; C. Guentheri, Marsh (not in B.M.); C. capensis A.S.W.; C. *Phillipsi*, Ag.; C. *Kaupi*, Ag.; C. runcinatus, Plien.; C. Hislopianus, Oldham; C. Hunterianus, Oldham.

Here are placed Gosfordia truncata, A. S. W.; and Conchopoma gadiforme, Kner.

Order II., ARTHRODIRA, with a single family, *Coccosteidæ* (R. H. Traquair does not think it proved that these were autostylic).

The species are: Coccosteus **decipiens*, Ag.; C. *minor*, Miller; C. **disjectus* (sp. nov.) [see fig. 78]. C. hercynius, v. Meyer; Brachydirus ——, Phlyctænaspis acadica, Whit.; P. **anglica*, Traq.; Chelyophorus ——, *Dinichthys ——, Titanichthys ——, Macropetalichthys ——, Homosteus formosissimus, Asmuss; H. **Milleri*, Traq.; Heterosteus Asmussi (Ag.).

Near this group are placed Asterosteus ——, Phyllolepis *concentrica*, Ag.; Holonema ——, and Mylostoma ——.

Sub-class V., TELEOSTOMI; Order I., CROSSOPTERYGII. —The extinct forms are divided into three sub-orders by the characters of their "axonosts" and "baseosts," *i.e.*, their fin bones.

Family *Tarrasiidæ* is separated as sub-order I., HAPLISTIA. The species is Tarrasius *problematicus*, Traq.

Sub-order II., RHIPIDISTIA (the third sub-order, TAXISTIA of Cope, being merged in this, Traquair).

Synopsis of families:—

I. Pectoral fins acutely lobate.
 Tooth structure dendrodont, scales cycloidal. *Holoptychiidæ*.
II. Pectoral fins obtusely lobate.
 Tooth structure slightly infolded, scales cycloidal. *Rhizodontidæ*.
 Tooth structure slightly infolded, scales rhomboidal. *Osteolepidæ*.
III. With a dentigerous presymphysial bone. *Onychodontidæ*.

(R. H. Traquair states that the Rhizodonts have a wonderfully complex tooth at the base, but do not form the interlacing network of the Dendrodonts.)

The species of *Holoptychiidæ* are: Holoptychius *nobilissimus*, Ag.; H. *giganteus*, Ag.; H. americanus; Leidy; H. Halli,

Leidy; H. **Flemingi*, Ag.; H. (Glyptolepis) **leptopterus*, Ag.; H. (G.) quebecensis, Whit.; H. (G.) *paucidens* (Ag.); Dendrodus *biporcatus*, Owen; D. *strigatus*, Owen.

The species of *Rhizodontidæ* are: Rhizodus **Hibberti*, Ag. and H.; R. **ornatus*, Traq.; Strepsodus **sauroides* (Binney); S. *striolatus*, Traq.; S. *sulcidens*, H. and A.; S. *Portlocki* (Portl.); S. *Hardingi* (Dawson) (not in B.M.); Rhizodopsis **sauroides* Young; R. *robusta (sp. nov.), squamation more robust. Silesia: Gyroptychius *microlepidotus*, Ag.; Tristichopterus *alatus*, Eg.; Eusthenopteron Foordi, Whit.; Cricodus *incurvus*, Duff; C. Wenjukowi, Rohon; Sauripterus *favosus* (Ag.); S. **anglicus* (sp. nov.), smaller tooth, straight, regular scales, robust, with coarse tubercles [fig. 79.]

The species of *Osteolepidæ* are: Osteolepis **macrolepidotus*, Ag.; O. *microlepidotus*, Pander; Thursius *macrolepidotus*, S. and M.; T. **pholidotus*, Traq.; Diplopterus *Agassizi*, Traill; Megalichthys **Hibberti*, Ag.; M. **coccolepis*, Young; M. *intermedius* (sp. nov.), the same as previously called M. rugosus, and figured by Ward [*see* No. **407**, 1890] as Rhomboptychius [new name apparently given because the specimen first called "rugosus" is "specifically indeterminable"]; M. *laticeps*, Traq.; M. *pygmæus*, Traq.; Glyptopomus *minus*, Ag.;[1] G. Sayrei, Newb. (not in B.M.); E. *Kinnairdi*, Huxley.

The species of *Onychodontidæ* are: Onychodus sigmoides, Newb. (not in B.M.); O. *anglicus*, A.S.W.

Sub-order III., Actinistia.—Comprises only the family *Cœlacanthidæ*.

The species are: Cœlacanthus *granulatus*, Ag.; C. *tingleyensis*, Davis; C. **elegans*, Newb.; C. robustus, Newb.; C. *elongatus*, Huxley (not in B.M.); C. **Huxleyi*, Traq.; C. gracilis, Ag.; Graphiurus ——, Diplurus ——, Undina penicillata, Münster; U. **gulo*, Eg. [*see* fig. 80]; U.? *barroviensis*, A.S.W.; Libys polypterus, Münster; L. superbus, Zittel (not in B.M.); Coccoderma ——, Heptanema ——, Macropoma **Mantelli*, Ag.

Sub-order IV., Cladistia.—No extinct types (*Polypteridæ*).

Order II., Actinopterygii.—Only the first "Division A" is here characterised, principally by the median fins having dermal rays more numerous than the endoskeletal supporting elements ("baseosts," Traquair). This includes Sub-order I., Chondrostei.

Synopsis of families [altered in form for brevity]:—

A. Ascending series—

Trunk elongate-fusiform, teeth slender, conical, or styliform.

Tail heterocercal. *Palæoniscidæ*.

Tail abbreviate heterocercal. *Catopteridæ*.

Trunk deeply fusiform, dentition obtuse. *Platysomatidæ*.

[1] Why not "min*or*," as Agassiz wrote, or Glyptopom*a*?

B. Degenerate series—
Cranial shield without azygos bones, branchiostegals present.
No teeth in adult, tail heterocercal, squamation rudimentary. *Chondrosteidæ*.
Teeth in adult, tail diphycercal, longitudinal scutes. *Belonorhynchidæ*.
Cranial shield with azygos bones, no branchiostegals, tail heterocercal.
No teeth in adult, longitudinal scutes. *Accipenseridæ*.
Minute teeth in adult, squamation rudimentary. *Polyodontidæ*.

The species of *Palæoniscidæ* are: Canobius *Ramsayi*, Traq.; C. *elegantulus*, Traq.; C. *pulchellus*, Traq.; C. *politus*, Traq.; C. *macrocephalus* (Traq.); Gonatodus *punctatus* (Ag.); G. **macrolepis*, Traq.; G. **parvidens*, Traq.; Amblypterus latus, Ag.; A. Traquairi (sp. nov.), dorsal contour not much arched, length = 4 times depth, Lebach; A. Duvernoyi, Ag.; A. Beaumonti, Traq.; A. decorus (Eg.); A. arcuatus (Eg.); A. Reussi (Hæckel) (not in B.M.); A. Blainvillei (Ag.); A. Voltzi (Ag.); Eurylepis tuberculata, Newb.; E. granulata, Newb.; Cheirolepis *Trailli*, Ag.; C. canadensis, Whit. (not in B.M.); Nematoptychius *Greenocki*, Traq.; Cycloptychius *carbonarius*, Young; C. *concentricus*, Traq.; Rhadinichthys *ornatissimus* (Ag.); R. *carinatus* (Ag.); R. *brevis*, Traq.; R. *elegantulus*, Traq.; R. *Macconochi*, Traq.; R. Cairnsi, (Jackson); R. Alberti (Jackson); R. modulus (Dawson); R. *tenuicauda*, Traq.; R. *Wardi* (Ward); R. *monensis* (Eg.); R. ? *angustulus*, Traq.; Pygopterus *Humboldti*, Ag.; Trachelacanthus ——, Urolepis ——, Phanerosteon *mirabile*, Traq.; Palæoniscus *Freieslebeni*, Blain.; P. magnus, Ag.; P. *macropomus, Ag.; P. *longissimus*, Ag.; P. *macrophthalmus*, Ag.; Apateolepis australis, A.S.W.; Elonichthys Germari, Giebel; E. *semistriatus*, Traq.; E. peltigerus, Newb.; E. *Aitkeni*, Traq.; E. *striatus* (Ag.); E. macropterus (Bronn); E. gigas, Fritsch; E. *Egertoni* (Eg.); E. *Robisoni*, Traq.; E. *Bucklandi* (Ag.); E. *pulcherrimus*, Traq.; E. *serratus*, Traq.; E. ? *Portlocki* (Eg.); Acrolepis *Sedgwicki* (Ag.); A. *exsculpta*, Kurtze; A. *Hopkinsi*, M'Coy; A. **Wilsoni*, Traq.; A. *semigranulosa*, Traq.; A. *ortholepis*, Traq.; A. hortonensis, Dawson; A. *digitata (sp. nov.), with posterior denticles, S. Africa; Gyrolepis *Alberti*, Ag.; G. ornata (Giebel) (not in B.M.); G. Quenstedti, Dames (not in B.M.); G. Agassizi (Münster) (not in B.M.); Atherstonia scutata, A.S.W.; Myriolepis Clarkei (Eg.); Oxygnathus *ornatus*, Ag.; O. *Egertoni*, Eg.; Centrolepis *aspera*, Eg.; Cryphiolepis **striata*, Traq.; Coccolepis Bucklandi, Ag. (not in B.M.); C. *Andrewsi* (sp. nov.), small, very long, scales very coarsely granulated; anal fin ⅜ the dorsal, fulcra of upper caudal lobe numerous, long, and slender, Purbeck; C. *liassica*, A.S.W.; C. australis, A.S.W. (to be described, not in B.M.), N.S. Wales; Holurus *Parki*, Traq.

The species of *Platysomatidæ* are: Eurynotus **crenatus*, Ag.; Mesolepis *Wardi*, Young; M. *scalaris*, Young; Globulodus *macrurus*, Ag.; Wardichthys *cyclosoma*, Traq.; Cheirodus *granulosus* (Young); C. *striatus* (H. and A.); Cheirodopsis *Geikiei*, Traq.; Platysomus **gibbosus*, Ag.; P. *Forsteri*, H. and A.; P. *parvulus*, Will.; P. *tenuistriatus*, Traq. (not in B.M.); P. rotundus, H. and A. (not in B.M.); P. *superbus*, Traq.

The measures throughout are given in decimals, of what is not stated, but apparently of a metre. Numerous other species are quoted under several genera, but have apparently not been verified.

***325. Woodward, A. S.—Note on some Dermal Plates of *Homosteus* from the Old Red Sandstone of Caithness.**

Proc. Zool. Soc. for 1891, p. 198.

A detailed description is given of a median occipital plate, a lateral occipital, an anterior median ventral and an anterior ventro-lateral plate, found in association at Thurso. These show that the cranial shield extended backwards far beyond the hinder extremity of the brain, while the ventral shield was apparently as remarkably short and broad as the dorsal. Four woodcuts are given.

326. Traquair, R. H.—List of the Fossil Dipnoi and Ganoidei of Fife and the Lothians.

Proc. Roy. Soc. Edinburgh, vol. xvii., p. 385 (dated 25/9/90).

This is a revision of the genera and species up to date. The list is as follows. U.O.R. = Upper Old Red. C.S. = Calciferous Sandstone. C.L. = Carboniferous Limestone. C.M. = Coal-measures :—

Phaneropleuron Andersoni, Huxl., U.O.R.
Ctenodus interruptus, Barkas, C.S.
——— cristatus, Ag., C.M.
——— angustulus, Traq. C.L.
Sagenodus quinquecostatus, Traq., C.L.
Uronemus lobatus, Ag., C.S.
——— splendens, Traq., C.L.
Acanthodes sulcatus, Ag., C.S.
——— Wardi, Eg., C.M.
Acanthodopsis Wardi, H. & A., C.M.
Bothriolepis hydrophilus, Ag., U.O.R.
Holoptychius Flemingii, Ag., U.O.R.
——— nobilissimus, Ag., U.O.R.
Rhizodus Hibberti, *Ag.*, C.S.
——— ornatus, Traq., C.S.
Megalichthys Hibberti, Ag., C.M.
Cælacanthus lepturus, Ag., C.M.
Elonichthys nemopterus, *Ag.*, C.S.
——— Bucklandi, *Ag.*, C.S., C.L.
——— pectinatus, Traq., C.S., C.L.
——— multistriatus, Traq., C.L.
——— striatus, *Ag.*, C.S.
Rhadinichthys ornatissimus, *Ag.* C.S.
——— carinatus, *Ag.*, C.S.
——— brevis, Traq., C.S.
——— tenuicauda. Traq., C.L.
——— ferox, Traq., C.S
——— macrocephalus, Traq., C.S.

Archichthys sulcidens, H. & A., C.M.
——— Portlocki, *Ag.*, C.S.
Strepsodus sauroides, *Bonney*, C.M.
——— striatulus, Traq., C.L.
——— minor, Traq., C.S.
Rhizodopsis sauroides, *Will.*, C.M.
Glyptopomus minor, Ag., U.O.R.
Glyptolæmus Kinnairdi, Hux., U.O.R.
Megalichthys laticeps, Traq., C.S.
——— lævis, Traq., C.S.
Nematoptychius Greenocki, Ag., C.S.
Acrolepis semigranulosus, Traq., C.S.
Gonatodus punctatus, Ag., C.S.
——— macrolepis, Traq., C.S.
——— parvidens, Traq., C. L.
Drydenius insignis, Traq., C.L.
Cryphiolepis striatus, Traq., C.L.
Eurynotus crenatus, Ag., C.S.
——— microlepidotus, Traq., C.L.
Platysomus parvulus, Ag., C.M.
Cheirodus crassus, Traq., C.L.

In the notes on these species are the descriptions of new species: *Strepsodus minor*, spec. nov. Scales ⅞ in. by ⅛ in. quadrate, surface with fine concentric striæ and radiating lines. *Megalichthys lævis*, spec. nov., a small species with thin scales, which lack the usual keel on the under surface, from the Dunnet oil shale. The numerous species of *Elonichthys* of the *Robisoni* type, which he formerly recognised, he now unites under *E. nemopterus* as varieties, viz., *striolatus*, *intermedius*, *Dunsii*, *tenuiserratus*, and *affinis*, as no fundamental distinction separates them. *E. ovatus* is dropped as due to distortion. *Elonichthys multistriatus*, spec. nov., body fusiform, head bones like those of *E. pectinatus*, scales rectangular, higher than broad, covered with fine, sharp, sub-parallel but bifurcating raised striæ, crossing obliquely; a strong pointed and grooved spine from the upper margin, C.L. *Elonichthys striatus* is withdrawn from *Cosmoptychius*, as the former genus, like the latter, has a triangular accessory plate in the operculum. *Rhadinichthys lepturus* is cancelled as the young of *R. ornatissimus*, and *R. Geikiei* as belonging to *R. carinatus*, also *Nematoptychius gracilis* as the young of *N. Greenocki*. *Rhadinichthys macrocephalus*, spec. nov., like *R. carinatus*, but with a large head, shorter, with few scale bands, C.S. *Acrolepis semigranulosus*, spec. nov., scales shaped as in *A. Hopkinsi*, with innumerable closely-set fine ridges tending to break up into tubercles, oblique and tortuous, from the Dunnett shale. *Drydenius insignis*, gen. et spec. nov. Generally like *Gonatodus*, but "the hinder part of the maxilla forms a short expanded plate, from the *middle* of the anterior aspect of which the narrow anterior or suborbital process extends, so that the tooth-bearing margin is posteriorly bent suddenly downwards." The splenial element on its oral aspect "shows an area about the middle, and occupying more than one-third of its length, from which a row of six powerful cylindro-conical teeth arises, behind which are 3 or 4 small ones," from the Blackband Ironstone. *Eurynotus microlepidotus*, spec. nov., scales small, fins large, C.L. *Cheirodus crassus*, spec. nov., scales more coarsely ornamented than in *C.*

granulosus, internal rib less distinct, C.L. [No figures are given.]

***326. Davis, J. W.—On the Discovery of a New Species of Fossil Fish (*Strepsodus Brockbanki*) in the Upper Coal-Measures of Levenshulme, No. 6 Group, from the Railway Cutting at Levenshulme, near Manchester.**

Mem. and Proc. Manchester Lit. and Phil. Soc., vol. iv., p. 427.

Remains of teeth, jawbones, dermal and rib bones occur. The form of the teeth indicates *Strepsodus*, but the present species, *S. Brockbanki*, differs from *S. sauroides* in having a greater proportionate breadth, larger striæ, and a circular base, and the point is less twisted.

***327. Davis, J. W.—On Fossil Fish of the West Riding Coalfield.**

Rep. Brit. Assoc. for 1890, p. 822.

A history of the discovery of the remains, which now number over 50 species.

328. Browne, M.—Notes upon *Colobodus*, a Genus of Mesozoic Fossil Fishes.

Geol. Mag., Dec. 3, vol. viii., p. 501.

Abstract of paper read to the Brit. Assoc. in Aug., 1891.

The author has found some teeth in the bone bed at Aust and Watchet which he refers to this Muschelkalk genus. He thinks the teeth, head, and scales of this fish have often been described under other names, and speculates on it proving to be "identical with *Lepidotus*."

***329. Woodward, A. S.—*Pholidophorus germanicus*: An Addition to the Fish Fauna of the Upper Lias of Whitby.**

Geol. Mag., Dec. 3, vol. viii., p. 545.

This is another link between the Lias Fauna of Whitby and that of Württemberg. The specimens are in the Egerton and Enniskillen collection in the British Museum, and some attain 1 ft. in length. The pelvic fins are a little in advance of the middle of the trunk, and are provided with small fulcra; the dorsal fin is directly opposed to these. The scales have a peculiar ornament, having a faint coarse rugosity, tending to form parallel folds; the hinder margin is not serrated.

***330. Howes, G. B.—Observations on the Pectoral Fin-Skeleton of the Living Batoid Fishes and of the Extinct Genus *Squaloraja*, with Especial Reference to the Affinities of the Same.**

Proc. Zool. Soc. for 1890, p. 675.

The first part of the paper deals with recent fishes. As to *Squaloraja*, A. S. Woodward has referred it to the *Selachii Tectospondyli*, regarding the anterior of the two basal cartilages

which support the pectoral fin as mainly mesopterygial. The author, however, points out that the posterior one, or metapterygium, has its greatest vertical diameter in front, as in the Chimæroids, instead of behind the middle, as in Sharks. He therefore regards the fish as a Chimæroid, and as these have no mesopterygium, the anterior cartilage must be the proterygium.

***331. Newton, E. T.—The Geology of Parts of Cambridgeshire and Suffolk.**

Mem. Geol. Survey, p. 17.

Describes a new species of *Hybodus* as *H. Fisheri*. It is a spine 12 in. long by 1½ in. broad. The sides show irregular, longitudinal ridges, broken up and varying in size, between which there are smaller and more irregular ridges; anterior side keeled, posterior side denticulated. From the Kimmeridge Clay at Ely.

***332. Davis, J. W.—Fossil Fishes of the Chalk.**

Trans. Leeds Geol. Assoc., pl. vi., p. 9.

This consists of miscellaneous notes on the teeth of the *Lamnidæ*—both British and foreign. The general observations are the same as those recorded in No. **701** of 1890. The so-called species are, in many cases, regarded as "forms" only.

FOOTPRINTS.

***333. Smith, J.—Note on the Occurrence of Footprints in the Calciferous Sandstone between West Kilbride and Fairlie.**

Trans. Geol. Soc. Glasgow., vol. ix., pt. i., p. 201.

The footprints occur in a nearly vertical block still standing in the cutting, and are in relief on the under side. They are oval, with a notch at one end, and are 3 ins. long by 2 ins. broad, they lie in two rows 6—6½ ins. apart, and spaced in each row at about 8 ins. distance, seven in one row, six in the other, arranged quincuncially [fig. 20], the shorter row extends over a distance of 3 ft. 7 in. No name is assigned to them.

INVERTEBRATA.

***334. Newton, R. B.—Systematic List of the Frederick E. Edwards' Collection of British Oligocene and Eocene Mollusca in the British Museum (Natural History).**

London: 8vo, pp. xxviii., 365.

This list is a critical one, giving the author's views of the

correct names to be assigned to the genera and species. A vast number of generic names, however, are altered to suit the strictest law of priority, even when the name preoccupied has been a synonym when first imposed, and used for an animal belonging to an entirely different group.[1] It is practically a complete list of British Eocene and Oligocene Mollusca. In the following 1 = Lower, 2 = Middle, and 3 = Upper Eocene; 4 = Oligocene, including the Headon beds; * = Type in British Museum; Sow. = J. Sowerby; *Sow.* = J. de C. Sowerby. Common geological names of genera in square brackets.

LAMELLIBRANCHIATA—

Anomia
anomialis, Lam., 1—4.
*scabrosa, S.V.Wood., 1.
Ostrea
*adlata, S.V.W., 4.
*aliena, S.V.W., 2.
bellovacina, Lam., 1.
callifera, Lam 4.
cyathula ?, Lam., 2.
*cymbuloides, S.V.W., 1.
dorsata, Desh., 2, 3.
elegans ?, Desh., 2.
flabellula, Lam., 1—4.
gigantea, Sow., 1—3.
*gryphovicina, S.V.W., 1.
inflata ?, Desh., 2.
longirostris, Lam., 4.
*marginidentata, S.V.W., 2.
multicostata ?, Desh., 2
*pulchra, Sow., 1.
tabulata, *Sow.*, 1.
*tenera, Sow., 1, 2.
vectensis, Morr., 1.
*velata, S.V.W., 4.
ventilabrum, Goldf., 4.
*zonulata, S.V.W., 2.
Pecten
*bellicostatus, S.V.W., 4.
*carinatus, *Sow.*, 3.
*duplicatus, *Sow.*, 1.
idoneus, S.V.W., 2.
plebeius ?, Lam., 2.
reconditus, Sol., 2, 3.
squamula, Lam., 2.
triginta-radiatus, *Sow.*, 2.
Pseud-amusium
*contubernalis, S.V.W., 1.
*corneus, Sow., 1—3.
Lima
*compta, S.V.W., 3.
*expansa, *Sow.*, 2.
*soror, S.V.W, 3.
Spondylus
rarispina, Desh., 2.
Avicula
*arcuata, *Sow.*, 1.
*media, Sow., 1—4.
*papyracea, *Sow.*, 1
Vulsella
deperdita ?, Lam., 3.
Pinna
*affinis, Sow., 1.
*arcuata, Sow., 1.
margaritacea, Lam., 2, 3.
pyriformis, S.V.W., 1.
Mytilus
affinis, *Sow.*, 3, 4.
*strigillatus, S.V.W., 3.
Modiola
*bartonensis, S.V.W., 3.
*crassistriata, S.V.W., 2.
*depressa, Sow., 1.
*dimidiata, S.V.W., 3.
*diversa, S.V.W., 3.
*dorsata, Morr., 1.
*elegans, Sow., 1—4.
*eximia, S.V.W., 3.
*flabellula, S.V.W., 4.
hastata, Desh., 2.
*Mitchelli, Morr., 1.
*nodulifera, S.V.W., 3.
Modiola
Nysti, Nyst., 4.
Prestwichi, Morr., 4.
*pygmæa, S.V.W., 3.
seminuda, Desh., 3.
*simplex, *Sow.*, 1.
*subcancellata, S.V.W., 3.
subcarinata ?, Lam., 2, 3.
sulcata, Lam., 3.
tenuistriata, Mell., 3.
Lithodomus
Deshayesi, *Sow.*, 2.
Dreissensia (Dreissena)
Brardi, Fauj., 4.
Arca
appendiculata, Sow., 2—4.
biangula, Lam, 2, 3.
*depressa, *Sow.*, 1.
*dulwichiensis, S.V.W., 1.
*eximia, S.V.W., 2.
globulosa ?, Desh., 2, 3.
impolita, *Sow.*, 1.
interrupta, Lam., 2.
lævigata, Caill., 2—4.
laekeniana, Le Hon., 2.
Lyelli, Desh., 3.
modioliformis, Desh. 2.
*nitens, *Sow.*, 1.
planicosta, Desh., 2, 3.
*tessellata, S.V.W., 2.
*tumescens, S.V.W., 2, 3.
Websteri, Morr., 4.
Cucullæa
decussata, Park., 1.
Axinæa (Pectunculus)
*brevirostris, *Sow.*, 1.

[1] In the opinion of some, the rusty rubbish that is sometimes thus brought to light had better have been left to lie in obscurity.

Axinæa (Pectunculus)
*decussata, Sow., 1.
deleta, Sol., 2, 3.
*globosa, *Sow.*, 2.
*plumsteadiensis, Sow, 1.
*proxima, S.V.W., 3.
pulvinata, Lam., 2.
*quasipulvinata, S.V.W., 2.
*spissa, S.V.W., 1.
terebratularis, Lam., 1.

Limopsis
granulata, Lam , 2.
lentiformis ?, Desh., 1.
scalaris, *Sow.*, 3.

Trigonocælia
cancellata, Desh., 2.
deltoidea ?, Lam., 3, 4.

Nucula
*ampla, S.V.W., 2, 3.
bisulcata, *Sow.*, 2, 3.
*Bowerbanki, *Sow.*, 1.
*cardioides, S.V.W., 1.
*compressa, *Sow.*, 1.
*consobrina, S.V.W., 1.
*consors, S.V.W., 1.
*curvata, S.V.W., 1.
*Dixoni, S.V.W., 2.
*gracilenta, S.V.W., 1.
headonensis, Morr., 4.
*lissa, S.V.W., 2—4.
minor, Desh., 2.
*nudata, S.V.W., 4.
prælævigata, S.V.W., 1.
*prælonga, S.V.W., 3.
*prælongata, S.V.W., 2.
*protracta, S.V.W., 2.
*sericea, S.V.W., 2.
*sextans, S.V.W., 1.
*similis, Sow., 3.
*sphenoides, S.V.W., 2, 4.
subtransversa ?, Nyst. 2.
*thanetiana, S.V.W., 1.
*tumescens, S.V.W., 3, 4.
*venusta, S.V.W., 1.
*Wetherelli, *Sow.*, 1,

Nuculana (Leda)
amygdaloides, *Sow.*, 1.
costulata, Desh., 2.
Galeottiana, Nyst., 2, 3.

Nuculana (Leda)
*minima, Sow., 1—4.
oblata, S.V.W., 1.
*partim-striata, S.V.W., 1.
prisca, Desh., 1.
*propinqua, S.V.W., 4.
*substriata, Morr., 1.

Unio
*Edwardsi, S.V.W., 1.
Gibbsi, Morr., 4.
*Solandri, *Sow.*, 4.
*subparallela, S.V.W. 1.
*tumescens, S.V.W., 4.
*vectensis, S.V.W., 4.

Crassatella
*bartonensis, S.V.W., 3.
Bronni ?, Desh., 2, 3.
compressa, Lam., 2.
*corbuloides, S.V.W., 2.
gibbosula, Lam., 2.
grignonensis, Desh., 2, 3.
*plicata, Sow., 1—3.
*pumilio, S.V.W., 3.
sinuosa ?, Desh., 2, 3.
*Sowerbyi, S.V.W., 2, 4.
*subquadrata, S.V.W. 2, 3.
sulcata, Sol., 2, 3.
*tenuisulcata, S.V.W. 2, 3.

Astarte
*clarendonensis, S.V.W., 1.
*donacina, S.V.W., 1.
*elevata, G. B. Sow., 1.
*modicella, S.V.W., 2.
*rugata, Sow., 1.
*tenera, Morr., 1.

Cardita
acuticosta ?, Lam., 2.
*alticosta, S.V.W., 1.
Brongniarti, Mant., 1.
*carinata, Sow., 2.
*crebrisulcata, S.V.W., 2, 3.
Davidsoni, Desh., 3.
*deltoidea, Sow., 4.
elegans, Lam., 1—3.
imbricata, Chemn., 2.
mitis, Lam., 2.

Cardita
*oblonga, Sow., 2—4.
*obovata, S.V.W., 2.
planicosta, Lam., 2, 3.
paucicostata, Sandb., 4.
*simplex, S.V.W., 3, 4.
*sulcata, Sol., 3.

Lutetia
parisiensis, Desh., 1—3.

Woodia
crenulata ?, Desh., 3.

Erycina
breviuscula, Desh., 3.
tenuicula, Desh., 3.

Hindsiella (Hindsia)
inæquilobata, 2.

Lucina
Baudoni, Desh., 2.
concava, Desh., 4.
concentrica, Lam., 3.
elegans, Defr., 2, 3.
gibbosula, Lam., 2—4.
gigantea, Desh., 3.
saxorum, Lam., 2.
Thiernesi, Héb., 4.
ventricosa, Wat., 2.

Sportella
dubia, Desh., 2.

Divaricella
pulchella, Ag., 4.
Rigaultiana, Desh., 3.
serrata, *Sow.*, 2.

Diplodonta
dilatata, Phil., 2, 3.
ingens, Desh., 2.

Chama
calcarata, Lam., 2.
fimbriata, Defr., 2.
gigas, Desh., 2.
*prisca, S.V.W., 1.
*squamosa, Sol., 3.
sulcata, Desh., 2.
turgidula, Lam., 2, 3.

Verticordia
*obliquata, S.V.W., 2.
propinqua, S.V.W., 1.
*sulcata, Sow., 1.

Cardium
asperulum, Lam., 2.
obliquum, Lam., 3, 4.
ordinatum, Sow., 2.
porulosum, Sol., 2—4.

Protocardium
discors, Lam., 2, 3.
Edwardsi, Desh., 1.
fraudator, Desh., 2—4.
hantoniense, v. Kon., 4.

Protocardium
Hornesi, Desh., 1.
Laytoni, Morr., 1.
*nitens, Sow., 1.
parile, Desh., 2, 3.
*plumsteadianum, Sow., 1.
semigranulatum, Sow., 1, 2.
subdiscors?, D'Orb., 1.
turgidum, Sol., 3.
Wateleti, Desh., 1.

Hemicardium
cymbulare, Lam., 2.

Cyrena
arenaria, S.V.W., 4.
britannica, Desh., 1.
Charpentieri, Pot. and Mich., 2.
cordata, Morr., 1.
crassa?, Desh., 1.
*cuneiformis, Sow., 1.
cycladiformis, Desh., 4.
deperdita, Lam., 3, 4.
*dulwichiensis, Rich., 1.
gibbosula, Morr., 4.
obliqua?, Desh., 4.
*obovata, Sow. 3?, 4.
obtusa, Morr., 4.
pisum?, Desh., 4.
pulchra, *Sow.*, 4.
semistriata, Desh., 4.
tellinella, F. & D., 1.
transversa, Morr., 4.

Sphærium
Bristovi, Morr., 4.
tumidula, S.V.W., 4.

Arctica (Cyprina)
*Morrisi, *Sow.*, 1.
*nana, *Sow.*, 1.
scutellaria, Lam., 3, 4.

Trapezium (Cypricardia)
carinatum, Desh., 2.
parisiense, Desh., 2.
tenue, Desh., 3.
vaginoides, Desh., 3.

Anisocardia
isocardioides, Desh., 2, 3.
pectenifera, *Sow.*, 2—4.

Isocardia
*sulcata, Sow., 1.
transversa, Nyst., 4.

Meretrix (Cytherea)
bellovacina, Desh., 1.
delicatula?, Desh., 2.

Meretrix (Cytherea)
deltoidea, Lam., 2—4.
elegans, Lam., 2, 3.
incrassata, Sow., 4.
lævigata, Lam., 2, 3.
Lyelli, Morr., 4
nitidula, Lam., 2.
obliqua, Desh., 2, 3.
*orbicularis, Morr., 1.
parisiensis, Desh., 2, 3.
proxima, Desh., 1.
striatula, Desh., 2.
suberycinoides, Desh., 2.
suessoniensis, Wat., 1.
*transversa *Sow.*, 3.
trigonula, Desh., 2.

Donax
trigonula, Desh., 3.

Tellina
*ambigua, Sow., 3, 4.
Beyrichi, Desh., 1.
*Branderi, *Sow.*, 2, 3.
*canaliculata, Edw., 2.
*concinna, Edw., 2.
corbinoides?, Caill., 3.
dis-stria, Edw.
donacialis, Lam., 2.
*filosa, *Sow.*, 3.
filosa, Edw.
*hantoniensis, Edw., 3.
*lævis, Edw., 3.
lamellosa, Desh., 2.
*lamellulata, Edw., 3.
lunulata, Lam., 2.
*obovata, Edw., 2.
*plagia, Edw., 2, 3.
*reflexa, Edw., 2.
*rhomboidalis, Edw., 2.
rostralina?, Desh., 2.
scalaroides, Lam., 2, 3.
*speciosa, Edw., 2.
squamula, Edw.
subrotunda, Desh., 2.
tenuistria, Desh., 2.
*textilis, Edw., 2.
*tumescens, Edw., 2.

Gari (Psammobia)
debilis, Desh., 3.
*Edwardsi, Morr., 1.
*Hollowaysi, Sow., 2.
rudis, Lam., 3, 4.

Psammotea
compressa, *Sow.*, 2—4.

Syndosmya
Raulini, Desh., 2, 3.
splendens, *Sow.*, 1.

Solen
Dixoni, *Sow.*, 2.
obliquus, *Sow.*, 2.

Ensis
gracilis, *Sow.*, 2—4.

Cultellus
affinis, *Sow.*, 1—3.

Solecurtus
Deshayesi, D. Moul., 2, 3.

Cyrtodaria
*rutupiensis, Morr., 1.

Glycimeris (Panopæa)
*intermedia, Sow., 1—4.
*puella, *Sow.* 1.

Ptychina (Axinus)
*angulatus, Sow., 1.

Pholadomya
*cuneata, *Sow.*, 1.
*Dixoni, *Sow.*, 1.
Konincki, Nyst., 1.
margaritacea, Sow., 1.
virgulosa, *Sow.*, 1.

Thracia
*oblata, *Sow.*, 1.
*sulcata, *Sow.*, 2.

Cryptodon
*Goodhalli, *Sow.*, 1, 3.

Mactra
compressa, Desh., 2, 3.
semisulcata, Lam., 2.

Cardilia
Michelini, Desh., 2.

Mya
angustata, *Sow.*, 4.
*minor, Morr., 4.

Sphænia
angulata, Desh., 3.

Corbula
anatina?, Lam., 2, 3.
Arnouldi, Nyst., 1.
*costata, *Sow.*, 1—3.
cuspidata, Sow., 3, 4.
ficus, Sol., 3.
gallica, Lam., 2, 3.
*globosa, Sow., 1—3.
Lamarcki, Desh., 2, 3.
longirostris, Desh., 2, 3.
nitida, Sow., 4.
*pisum, Sow., 1—4.
regulbiensis, Morr., 1.
rugosa, Lam., 2.
subpisum, D'Orb., 4.
*vectensis, Morr., 4.

Neæroporomya
argentea, Lam., 2, 3.

Cuspidaria (Neæra)
*inflata, *Sow.*, 1.

Erodona (Potamomya)
*gregaria, Sow., 4.
*plana, Sow., 3, 4.
Rocellaria
ampullaria, Lam., 2, 3.
Defrancii, Desh., 1.
Rauliniana, Desh., 2.
Brechites
coronata, Desh., 2, 3.
Martesia
conoidea, Desh., 3.
elegans, Desh., 3.
Thovana (Dactylina)
Levesquei, Wat., 1.
Pholadidea
*Pechelli, *Sow.*, 1.
Teredo
*antenautæ, Sow., 1.
Teredina
personata, Lam., 1.

GASTEROPODA PROSOBRANCHIATA.—

Hippochrenes
*amplus, Sol., 1—4.
Rostellaria
excelsa, Gieb., 3.
*lucida, Sow., 1, 2.
Rimella
canalis, C. & B., 2, 3.
rimosa, Sol., 2—4.
Canarium (Strombidea)
*bartonense, Sow., 2, 3
Aporrhais
Sowerbii, Mant., 1, 4.
Seraphs
fusiformis, Lam., 2, 3.
*sopitus, Sol., 2—4.
Cypræa
*alata, Edw., 1.
*attenuata, Edw., 2.
*bartonensis, Edw., 3.
*Bowerbanki, *Sow.*, 2, 3.
*cancellata, Edw., 2.
*cavata, Edw., 2.
*globularis, Edw., 1, 2.
inflata, Lam., 2.
orthocheila, Edw., 2.
*oviformis, Sow., 1.
tuberculosa, Ducl., 2.
*tumescens, Edw., 2.
Trivia [Cypræa]
*platystoma, Edw., 3.
*Prestwichi, Edw., 1.
*Wetherelli, Edw., 1.
Amphiperas (Ovula)
*antiqua, Edw., 1.
Oliva
*Branderi, Sow., 2, 3.
gracilis, Lea, 2.
Salisburiana, Sow., 3.
Ancilla (Ancillaria)
*aveniformis, Sow., 3.
buccinoides, Lam., 2—4.
canalifera, Lam., 2, 3.
dubia, Desh., 3
fusiformis, *Sow.*, 2.
obtusa, *Sow.*, 2.
Studeri?, H. & R., 3.
Harpopsis
stromboides, Herm., 2.

Cassis (Cassidaria)
ambigua, Sol., 1—4.
calantica, Desh., 2.
coronata, Desh., 2.
nodosa, Sol., 1—3.
sulcaria? Desh., 2, 3.
*Smithi, *Sow.*, 1.
Pleurotoma
*acuminata, Sow., 1.
*cocciphora, Edw., 1.
*cochlis, Edw., 1.
*crassa, Edw., 1.
*crassicosta, Edw., 2, 3.
*cymæa, Edw., 4.
dentata, Lam , 2.
exorta, Sol., 2, 3.
fusiformis, *Sow.*, 1.
*goniæa, Edw., 2.
*helix, Edw., 1.
*inarata, *Sow.*, 2, 3.
*Keelei, Edw., 1.
*lanceolata, Edw., 3.
*lævigata, *Sow.*, 3.
Lehoni, Rou., 1.
*macilenta, Sol., 3.
*macrura, Edw., 1.
*microdonta, Edw., 2, 3.
*planetica, Edw., 2.
pyrulata, Desh., 1.
*rostrata, Sol., 3.
*stena, Edw., 1.
*sulculosa, Edw., 1.
*symmetrica, Edw., 1.
terebralis, Lam., 1, 2.
*teretrium, Edw., 1.
textiliosa, Desh., 2.
transversaria, Lam., 4.

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acuticosta?, Nyst., 3.
attenuata, Sow., 2.
*biconus, Edw., 3.
*bracheia, Edw., 2, 3.
*brevirostrum, *Sow.*, 3.
*coarctata, Edw., 3.
*conica, Edw., 1.
conoides, Sol., 2, 3.
*constricta, Edw., 2, 3.
*desmia, Edw., 3.

Pleurotoma
*dilinum, Edw., 3.
*dissimilis, Edw., 1, 3.
*Fisheri, Edw., 2.
*gomphoidea, Edw., 1, 3.
granulata, Lam., 2, 3.
headonensis, Morr., 4.
*helicoides, Edw., 3.
inflexa, Lam., 2.
*innexa, Sol., 3.
*lepta, Edw., 2.
*lissa, Edw., 1.
*microcheila, Edw., 3.
*nodosaria, Edw., 1.
nodulosa, Lam., 2.
plicata, Lam., 2.
*pupa, Edw., 1—3.
*pyrgota, Edw., 2, 4.
*scabriuscula, Edw., 3.
*sindonata, Edw., 2.
*subula, Edw., 1.
Tallavignesi, Rou., 1.
*tereticosta, Edw., 1.
*tricincta, Edw., 1.
*turgidula, Edw., 3.
*turpis, Edw., 1.
undata, Lam., 2.
*verticillum, Edw., 3.
*vicina, Edw., 3.

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*aspera, Edw., 3.
*callifera, Edw., 2, 3.
comma, Sow., 2.
*conifera, Edw., 2.
*crebrilinea, Edw., 2.
denticula, Bast., 1—4.
*divisa, Edw., 2.
*fasciolata, Edw., 1.
*gentilis, *Sow.*, 2, 3.
Konincki, Nyst., 1.
*mixta, Edw., 3
*Prestwichi, Edw., 1.
Selysi, Kon., 1.
*simillima, Edw., 1.
*tæniolata, Edw., 1.
Waterkeyni, Nyst., 1.
*Wetherelli, Edw., 1.
*zeta, Edw., 2.

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*abnormis, Edw., 1.

Pleurotoma
*acutisinuata, Edw., 2.
*cedilla, Edw., 3.
*curta, Edw., 3.
flexuosa, Goldf., 1.
*granata, Edw., 1, 3.
*hantoniensis, Edw., 4.
*hemileia, Edw., 3.
*insignis, Edw., 1.
*læviuscula, Edw., 4.
*ligata, Edw., 2.
*lima, Edw., 3.
*monerma, Edw., 1, 3.
obscurata, *Sow.*, 2.
*parilis, Edw., 1.
*puella, Edw. 3.
*pupoides, Edw., 1.
*reticulosa, Edw., 2, 3.
*rotella, Edw., 3.
*rotundata, Edw., 1, 3.
*scalarata, Edw., 2.
turbida, Sol., 3.
*varians, Edw., 3.
*variata, Edw., 1.
*Woodi, Edw., 4.
*zonulata, Edw., 3.

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*amphiconus, *Sow.*, 2.
glabrata, Lam., 2.
marginata, Lam., 2.
*prisca, Sol., 1, 3.
semistriata, Desh., 2.
Borsonia
biaritzana, Rou., 2.
*lineata, Edw., 3.
*semicostata, Edw., 3.
sulcata, Morr., 3, 4.
Conus
concinnus, Sow., 1.
deperditus, Brug., 2.
*diadema, Edw., 2.
*Lamarcki, Edw., 2.
lineatus, Sol., 2, 3.
*scabriculus, Sol., 3.
*velatus, *Sow.*, 2.
Conorbis
*alatus, Edw., 2—4.
dormitor, Sol., 3, 4.
Voluta
*ambigua, Sol., 3.
angusta, Desh., 2.
athleta, Sol., 2, 3.
Branderi, Defr., 2.
*calva, *Sow.*, 2.
cithara, Lam., 2.
costata, Sol., 2, 3.
crenulata, Lam., 2.
denudata, *Sow.*, 1.
*depauperata, *Sow.*, 3.

Voluta
depressa, Lam., 1.
digitalina, Lam., 3.
*elevata, *Sow.*, 1.
*geminata, *Sow.*, 4.
*horrida, Edw., 2.
*humerosa, Edw., 2, 3.
*luctatrix, Sol., 2, 3.
*maga, Edw., 2—4.
muricina, Brug., 1, 2.
mutata, Desh., 2—4.
*nodosa, *Sow.*, 1—3.
protensa, *Sow.*, 1.
*pugil, Edw., 2.
Rathieri, Héb., 4.
*recticosta, *Sow.*, 2.
*scalaris, *Sow.*, 3.
*selseiensis, Edw., 2.
*Solandri, Edw., 2, 3.
spinosa, L., 1—4.
*suspensa, Sol., 3.
suturalis, Nyst., 4.
*tricorona, *Sow.*, 1.
*uniplicata, *Sow.*, 2.
*Wetherelli, *Sow.*, 1.
Mitra
labratula, Lam., 2.
marginata, Lam., 3.
*obesa, Edw., 3.
*parva, *Sow.*, 1—3.
*porrecta, Edw., 2, 3.
*scabra, *Sow.*, 3.
*volutiformis, Edw., 3.
Marginella
*æstuarina, Edw., 4.
*bifido-plicata, Edw. 1—3.
eburnea, Lam., 2.
*gracilis, Edw., 1—3.
ovulata, Lam., 2.
*pusilla, Edw., 3.
*simplex, Edw., 4.
*vittata, Edw., 4.
Volvaria
*acutiuscula, Sow., 3.
Latirus
funiculosus, Lam., 2.
incertus, Desh., 2.
uniplicatus, Lam., 2.
Lampusia (Triton)
*arguta, Sol., 2, 3.
expansa, *Sow.*, 2.
flandrica, Kon., 2, 3.
Murex
Deslongchampsi, Desh., 2.
frondosus, Lam., 3.
*minax, Sol., 2—4.
obtusus ?, Desh., 3, 4.
plicatilis, Desh., 1.

Murex
sexdentatus, *Sow.*, 4.
spinulosus, Desh., 1.
subcristatus, D'Orb., 1.
Triplex [Murex]
asper, Sol., 2, 3.
*bispinosus, *Sow.*, 2, 3.
Caillati, Desh., 2.
crassicostatus, Desh., 2.
micropterus, Desh., 2.
tripteroides, Lam., 2, 3.
Typhis
fistulosus, Brocchi, 3.
*muticus, *Sow.*, 1.
*pungens, Sol., 2-4.
Trophon
subnodosum, Morr., 1.
*tuberosum, Sow., 1.
*undosum, *Sow.*, 2, 3.
Fusus
aciculatus, Lam., 3.
neglectus ?, Desh., 1.
porrectus, Sol., 1—3.
serratus, Desh., 2.
unicarinatus, Desh., 2, 3.
Clavalithes [Fusus]
angulatus, Lam., 2.
incultus, *Sow.*, 2.
*longævus, Sol., 2—4.
noæ, Chemn., 2.
rugosus, Lam., 2.
Sycum [Fusus]
globatum, Desh., 1.
ovatum, Beyr., 4.
*pyrus, Sol., 2, 3.
Chrysodomus [Fusus]
*antiquus, Sol., 1—3.
bifasciatus, Sow., 1.
*carinella, Sow., 3.
*complanatus, *Sow.*, 1.
*coniferus, Sow., 1.
Edwardsi, Morr., 4.
errans, Sol., 1—3.
eximius ? Beyr., 3.
gothicus, Desh., 2.
*lima, *Sow.*, 3.
Sandbergeri, Beyr., 4.
subcarinatus, Lam., 1.
Pisania (Euthria)
angusta ? Desh., 1.
concinna, G. B. Sow. 1.
*curta, Sow., 1.
*gradata, Sow., 1.
interrupta, Pilk., 1—3.
*labrata *Sow.*, 1, 4.
*lata, Sow.

Pisania (Euthria)
*lavata, *Sow.*, 3, 4.
scalaroides, Lam., 4.
sublamellosa, Desh., 1.
*trilineata, Sow., 1.
Metula
juncea, Sol., 1.
Cantharus
crassicostatus, Desh., 2.
polygonus, Lam., 2.
semiplicatus, Desh., 2
Strepsidura
armata, *Sow.*, 3, 4.
turgida, Sol., 2, 3.
Pyrula
Greenwoodi, *Sow.*, 2, 3.
nexilis, Sol., 2, 3.
nodulifera, G.B. Sow., 1.
plicatula, Beyr., 3.
Smithi, *Sow.*, 1, 2, 3.
Pseudoliva
fissurata, Desh., 1, 2.
obtusa, Desh., 1, 2.
*ovalis, *Sow.*, 2.
semicostata, Desh., 1.
Cominella
*canaliculata, *Sow.*, 3.
*deserta, Sol., 3, 4.
Phos
defossus, Pilk., 3.
Cuma
monoplex, Sandb., 4.
Cancellaria
costulata, Lam., 2.
elongata, Nyst., 4.
*evulsa, Sol., 2, 3.
excellens, Beyr., 2.
læviuscula, Sow., 3, 4.
nitens, Beyr., 2, 3.
quadrata, Sow., 3.
suturalis, Sow., 2.
Cerithioderma (Mesostoma)
grata, Desh., 1.
pulchra, Desh., 2.
Terebra
plicata, Lam., 2, 3.
Obeliscus (Syrnola)
angustus, Desh., 2—4.
clandestinus, Desh., 1.
microstoma, Desh., 2, 3.
*minimus, Sow., 4.
miser ?, Desh., 2.
pyramis ?, Desh., 2, 3.
Odostomia
alligata, Desh., 3.
hordeola, Lam., 1—4.

Turbonilla (Chemnitzia)
compta, Desh., 3.
*costata, Sow., 3.
pulchra, Desh., 3, 4.
scalaroides ?, Desh., 3.
Eulima
Deshayesi, Cossm., 2, 3.
*truncata, Sow., 4.
Niso
terebellata, Lam., 2.
Cerithium
Brocchi, Desh., 2.
denticulatum, Lam., 4.
filiferum, Desh., 2.
mutabile, Lam., 2, 3.
parvirostrum, *Sow.*, 2.
serratum, Brug., 2, 3.
tuberculosum, Lam., 2.
Campanile [Cerithium]
cornucopiæ, Sow., 2.
giganteum, Lam., 2.
*incomptum, *Sow.*, 2.
Semivertagus [Cerithium]
unisulcatus, Lam., 2.
Brachytrema [Cerithium]
Boblayi, Desh., 4.
muricoides, Lam., 2.
Bittium [Cerithium]
semi-granosum, Lam., 2, 3.
terebrale, Lam., 3.
Cerithiella (Lovenella)
cancellata, *Sow.*, 2, 3.
clava, Lam., 2.
multispirata, Desh., 4.
mundula, Desh., 1.
prælonga, Desh., 1—3
Triforis
ambigua, Desh., 2.
Potamides
Austeni, Morr., 4.
cinctus, Brug., 4.
conarius, Bayan, 2, 3.
conjunctus, Desh., 2.
conoideus, Lam., 2.
Dixoni, Desh., 2.
*duplex, Sow., 4.
elegans, Desh, 2.
emarginatus, Lam., 2.
*funatus, Sow., 1.
gradatus, Desh., 2.
margaritæ, Cossm., 4.
perditus, Bayan, 4.
Sedgwicki, Morr., 4.
semicoronatus, Lam., 2.

Potamides
submargaritaceus, D'Orb., 4.
submarginatus, D'Orb., 2—4.
tricarinatus, Lam., 4.
vagus, Sol., 4.
*ventricosus, Sow., 4.
Pyrazus [Cerithium]
angulatus, Sol., 2, 3.
angulosus, Lam., 2.
Terebralia [Cerithium]
Bonellii, Desh., 2.
plicata, Brug., 4.
Batillaria [Cerithium]
Bouei, Desh., 2.
calcitrapoides, Lam., 2.
clandestina, Desh., 2.
*concava, Sow., 3, 4.
echidnoides, Lam., 2, 3.
pleurotomoides, Lam., 2.
Melania
*acuta, Sow., 4.
Heyseana, Phill., 3,
Nysti, Nyst., 4.
Melanatria
Castellini, Brong., 3.
inquinata, Defr., 1.
Faunus (Pirena)
*rigidus, Sol., 3.
Coptostylus [Melanopsis]
brevis, *Sow.*, 4.
Melanopsis
buccinoidea, Fér., 1—3.
buccinulum ?, Desh., 1.
carinata, *Sow.*, 2—4.
fusiformis, Sow., 4.
sodalis, Desh., 1.
subcarinata, Morr., 4.
*subulata, Sow., 4.
Bayania [Melania]
corrugata, Lam., 4.
*fasciata, Sow., 4.
hordacea, Lam., 2.
Turritella
*brevis, Sow., 3.
carinifera, Desh., 2.
Dixoni, Desh., 1.
edita, Sol., 3.
granulosa, Desh., 2, 3.
imbricataria, Lam., 2, 3.
sulcifera, Desh., 2.
terebellata, Lam., 1, 2.

Ampullina
sigaretina, Lam., 1—3.
sphærica, Desh., 2.
splendida, Desh., 2, 3.
Willemeti, Desh., 2, 3.
Calyptræa
*aperta, Sol., 3, 4.
lævis, Desh., 2, 4.
*obliqua, Sow., 2—4.
striatella, Nyst., 3.
suessoniensis. D'Orb., 1.
Capulus
pennata, Lam., 2, 3.
singularis, Desh., 3.
squamæformis, Lam., 2, 3.
Hipponyx
cornucopiæ, Lam., 2.
dilatatus, Lam., 2.
Cyclotus
*cinctus, Edw., 4.
*nudus, Edw., 4.
Craspedopoma
*Elizabethæ, Edw., 4.
Hartmannia R.B.N. nom. nov. (Pomatias)
*heterostoma, Edw., 4.
Dissostoma
mumia, Lam., 4.
Callianella R.B.N. nom. nov. (Callia)
lævis, Sandb., 4.
Patella
striata, *Sow.*, 2.
Nerita
globosa, *Sow.*, 1.
parisiensis, Desh., 2.
pentastoma, Desh., 2.
tricarinata, Lam., 2.
Neritina
aperta, *Sow.*
*concava, *Sow.*, 4.
fulminifera ?, Sandb., 4.
globulus, Fér., 1.
Passyana ?, Desh., 3.
planulata, Sandb., 4.
tristis, Forbes, 4.
vicina, Melleville, 1.
Teinostoma
decussatum, Sandb., 4.
dubium, Lam., 2, 3.
margaritula, Desh., 3.
*minutum, *Sow.*, 2.
mite, Desh., 3.
priscum, Desh., 1.
Tectus [Trochus]
ornatus, Lam., 2.
Gibbula
rhenana, Sandb., 4.
Calliostoma
*nodulosum, Sol., 3.
Collonia
callifera, Desh., 2.
canalifera, Lam., 3.
Liotia
Warni, Defr., 2.
Fissurella
*Edwardsi, *Sow.*, 2.
labiata ?, Lam., 2.
squamosa, Desh., 2.
Emarginula
*obtusa, *Sow.*, 2.
Scutum (Parmophorus)
elongatum, Lam., 2.

GASTEROPODA OPISTHOBRANCHIATA :—

Acteon
alter ?, Desh., 4.
dactylinus ?, Desh., 4.
Gardneri ? Cossm., 2, 3.
limneiformis, Sandb., 4.
sphæriculus, Desh., 3.
striatinus, Desh., 2, 4.
subinflatus, D'Orb., 2, 3.
sulcatus, Lam., 2.
turgidus, Desh., 1.
Solidula
simulata, Sol., 1—3.
Crenilabium
*crenatum, *Sow.*, 2—4.
Ringicula
bezanconi, Morl., 3.
Langlassei, Morl., 2.
ringens, Lam., 1, 2.
Sandbergeri, Morl., 4.
Scaphander
Brongniarti ?, Desh., 2.
*Edwardsi, *Sow.*, 2.
parisiensis, D'Orb., 1, 3.
pulchellus, Desh., 3.
Philine (Bullæa)
excavata ?, Desh., 3.
expansa, *Sow.*, 2.
Bulla
globulus, Desh., 1, 2.
Bullinella R.B.N. nom. nov. (Cylichna)
angystoma, Desh., 2, 3.
attenuata, *Sow.*, 2, 3.
conoidea, Sandb., 4.
consors, Desh., 1.
constricta, *Sow*, 3.
coronata, Lam., 2, 3.
Bullinella
cylindroides ?, Desh., 2.
*elliptica, *Sow.*, 2, 3.
Sowerbyi, Nyst., 2, 3.
*uniplicata, *Sow.*, 1, 2.
Acera
striatella, Lam., 3.
Atys
biumbilicata ?, Desh., 2.
Lamarcki, Desh., 4.
sulcatina, Desh., 1.
Volvulella R.B.N. nom. nov. (Volvula)
extensa, *Sow.*, 2, 3.
*lanceolata, *Sow.*, 2, 3.
Umbrella
laudunensis, Mellev., 2.

POLYPLACOPHORA :—

Chiton, sp., 3.

PULMONATA :—

Helix
*D'Urbani, Edw., 4.
*headonensis, Edw., 4.
*occlusa, Edw., 4.
*omphalus, Edw., 4.
pseudo-globosa, D'Orb., 4.
Helix
pseudo-labyrinthica, Sandb., 4.
sconciensis, Gardn., 4.
*sublabyrinthica, Edw., 4.
*tropifera, Edw., 4.
Helix
*vectiensis, Edw., 4.
Amphidromus (Rillyia)
ellipticus, Sow., 4.
lævolongus, Boubée, 4
*tenuistriatus, G. B. Sow, 1.

Pupa
*oryza, Edw., 4.
*perdentata, Edw., 4.
Clausilia
*striatula, Edw., 4.
Megaspira
cylindrica, Gard., 1.
Melampus
tridentatus, Edw., 4.
Pedipes
*glaber, Edw., 3.
Succinea
*imperspicua, Edw., 4.
sparnacensis?, Desh., 4.
Glandina
*convexa, Wood., 4.
costellata, Sow., 4.
Limnæa
*angusta, Edw., 4.
*arenularia, Desh., 4.
*caudata, Edw., 4.

Limnæa
*cincta, Edw., 4.
*columellaris, *Sow.*, 4.
convexa, Edw., 4.
*costellata, Edw., 4.
fabula, Brongn., 4.
*fusiformis, Sow., 4.
*gibbosula, Edw., 4.
longiscata, Brongn., 4.
minima, Sow., 4.
*mixta, Edw., 4.
ovum?, Brongn., 4.
pyramidalis, Brongn., 4.
*recta, Edw., 4.
*sublata, Edw., 4.
*subquadrata, Edw., 4.
*sulcata, Edw., 4.
*tenuis, Edw., 4.
*tumida, Edw., 4.
Pitharella
*Rickmani, Edw., 1.

Ancylus
latus, Edw., 4.
Acroloxus (Velletia)
*elegans, *Sow.*, 4.
Planorbis
*biangulatus, Edw., 4.
*discus, Edw., 4.
*elegans, Edw., 4.
*euomphalus, Sow., 4.
goniobasis, Sandb., 4.
*hemistoma, Sow., 4.
lens, Brongn., 4.
*obtusus, Sow., 4.
*oligyratus, Edw., 4.
*platystoma, Edw., 4.
Sowerbyi, Bronn., 4.
*tropis, Edw., 4.
Camptoceras
*priscum, God. Aust., 1.

SCAPHOPODA:—

Fustiaria [Dentalium]
*anceps, *Sow.*, 1.
brevis, Desh., 1
circinata, G. B. Sow., 2.
fissura, Lam., 2.

Fustiaria [Dentalium]
grandis, Desh., 2.
lucida, Desh., 2
*nitens, Sow., 1.
parisiensis, D'Orb., 2.
pellucens, Desh., 2, 3.

Fustiaria [Dentalium]
*striata, Sow., 2, 3.
substriata, Desh., 2, 3.
Siphonodentalium
breve, Desh., 2

CEPHALOPODA DIBRANCHIATA:—

Belosepia
Blainvilli, Desh., 1, 2.
*Oweni, *Sow.*, 2.
sepioidea, Blainv., 2, 3.

Beloptera
belemnoidea, Blainv. 2.
Levesquei, Fér. & D'Orb., 1.

Belemnosis
*anomala, *Sow.*, 1.

CEPHALOPODA TETRABRANCHIATA:—

Nautilus
centralis, Sow., 1.
*imperialis, Sow., 1, 2.
regalis, Sow., 1.
Sowerbyi, *Sow.*, 1.

Nautilus
*urbanus, *Sow.*, 1
Hercoglossa
Cassiniana, Foord & Crick, 1.

Aturia
*Charlesworthi, Foord, 1.
*Parkinsoni, Edw., 1.
*ziczac, Sow., 1, 2.

CEPHALOPODA.

***335. Foord, A. H.—Catalogue of the Fossil Cephalopoda in the British Museum (Natural History), Cromwell Road, S.W.**

Part II. London: pp. 407. Reviewed in Geol. Mag., p. 324.

This part contains the following species: (British in italics, * figured):—

Sub-order NAUTILIDÆ (continued); Fam. *Lituitidæ.*—Lituites *lituus, Montf.; L.? *ibex*, Sow. This being the only possible British Lituites, the presence of the genus here "must be considered as very far from satisfactorily deter-

mined." Ophidioceras articulatum (Sow.); O. *geometricum*, Blake; O. *simplex, Barr.; O. rudens, Barr.; O. tessellatum, Barr.

Fam. *Trochoceratidæ*.—Trochoceras lamellosum, His.; T. convolvans, His.; T. *speciosum*, Barr.; T. *priscum*, Barr. (new as British); T. *tortuosum* ?, Sow.; T. distortum, Barr.; T. Davidsoni, Barr.; T. secula, Barr.; T. boreale, Foord (sp. nov.), whorls in contact, section elliptical, axes 3 : 4, siphuncle extramedial, septa $\frac{2}{11}$ diam. of whorl, Arctic America; T. subcostatum, Ang.; T. *regulare*, Blake; T. *giganteum*, Sow.; T. *rapax* ?, Barr.; T. *arietinum* ?, Barr.; T. *equisetum* (Blake); T. Sandbergeri, Barr.; T. *subquadratum* (sp. nov.). Asymmetry very slight, section subquadrate, increase rapid, septa $\frac{3}{8}$ whorl diameter, ribs prominent, recurved, with a deep sinus on the front [fig. 21]; T. *striatum*, Blake; T. *cornuarietis*, Sow.; T. optatum, Barr.; T. *trochoides*, Barr. (doubtfully British); T. nodosum, Barr.; T. *asperum*, Barr; T. degener, Barr; T. disjunctum, Barr.; T. pulchrum, Barr.; T. americanum ?, Bill.; T. *Halli, Foord (= Lituites undatus, Hall part).

Fam. *Nautilidæ*.—Trocholites *undosus*, Sow.; T. ammonius, Conrad; T. planorbiformis, Conrad. The British specimens which have been referred to this are not identical in character of ornamentation. T. *scoticus* ?, Blake; T. Odini (Eichw.); T. ? falcigerus (Eichw.); T. antiquissimus (Eichw.); T. iuliformis (Salter); Gyroceras[1] alatum, Barr.; G. *ornatum* (D'A. & V.); G. *eifelense* (D'A. & V.); G. cyclops, Hall; G. trivolve, Conrad; G. *Luidii* (Mart.); G. **hibernicum* (sp. nov.), vacuity large, whorls in contact, section quadrangular, nine coarse longitudinal ridges on the sides, numerous fine ones on the front, nodulated by transverse lines $\frac{1}{24}$ in. apart [fig. 22]; G. *ornatissimum*, de Kon. (new as British); G. tessellatum, de Kon.; G. serratum, de Kon.; G. (Apioceras) **compressum* (sp. nov.), shell composed of $1\frac{1}{2}$ volutions [only half a whorl shown in figure], less curved in older part, section oval, then subtriangular, sutures without sinus, shell smooth. "Ratio of ventro-dorsal to transverse diameter, 19 : 29" [fig. 23]. G. (Trigonoceras) **paradoxicum* (Sow.); G. (T.) aigoceras (Münster); Hercoceras *mirum, Barr.; Barrandioceras **bohemicum* (Barr.); B. Sternbergi (Barr.); B. tyrannus (Barr.); B. *holtianum*, Blake; B. Sacheri (Barr.); B. oriens (Hall); Discites *Omalianus*, de Kon. = N. *tetragonus*, Ph., but his description is defective; D. *Leveilleanus* (de Kon.); D. *discus* (Sow.); D. *discors*, M'Coy; D. **compressus* (Sow.); D. *planotergatus*, M'Coy; D. *sulcatus*, Sow.; D. *bisulcatus* (de Kon.);

[1] The author appears to adopt the views of Hyatt, but that writer rejects such names as Gyroceras as only one stage of evolution of a series; species also with whorls in contact are included.

D.? involvens (Salter); D. (Phacoceras) *oxystomus* (Ph.); Ephippioceras *bilobatum* (Sow.). E. **clitellarium*, Sow.; E. *costatum* (sp. nov.), septa closer, forming a more acute forward lobe on the front, with transverse ribs strongest on the sides, crossing the septa obliquely, and forming a shallow sinus [fig. 24]. Cælonautilus **cariniferus* (Sow.); C. **multicarinatus*, Sow.; C. **paucicarinatus* (sp. nov.=C. *multicarinatus* pars. (Sow. fig. 2), differs from *C. cariniferus* in having an extra keel inside the umbilicus [fig. 25]; C. *pinguis (de Kon.); C. Koninckii (D'Orb.); C. *subsulcatus* (Ph.); C. *quadratus* (Flem.); C. sulcifer (Leveillé); C. **gradus* (sp. nov.) umbilicus step-like, open whorls subquadrate, front concave, with two keels on each side, broad transverse folds on the inner whorls, septa 38 per whorl, siphuncle extramedial, tapering slow [fig. 26]; C. **globatus* (Sow.); C. *bistrialis* (Ph.); C. *derbiensis* (sp. nov. = C. *Chesterensis*, de Kon.) broader, flatter, less globose, umbilical margins rounded and not angular; and var. *globularis*; C. *infundibulum* (de Kon.). Pleuronautilus *falcatus* (Sow.); P. *nodoso-carinatus* (Römer); P. distinctus, Mojs.; P. subgemmatus, Mojs.; Temnocheilus *tuberculatus* (Sow.); T. * *Cricki* (sp. nov.), body chamber only, front slightly concave, with acute lateral angles, section roughly hexagonal, surface smooth, siphuncle central [fig. 27]; T. *concavus* (Sow.); T. * *carbonarius* (sp. nov.), body chamber only, not so concave on the front as *T. concavus*, and has "a row of nodes along the peripheral border" [fig. 28]; T. * latus, M. & W.; T. Coxanus, M. & W.; T. goliathus (Waagen); T. *Freieslebeni*, Gein.; T. angustus, Moys.; T. bidorsatus (Schl.); T. nodosus (Münster); T. (Centroceras) * tetragonus, (D'A. and de V.); Solenocheilus **caledonicus* (sp. nov.), height to width 17 : 40, section rounded, depressed on the front, with a spout-like projection on either side at the edge of the umbilicus, siphuncle central [fig. 29]; S. *dorsalis* (Ph.); S. * *hibernicus*, Foord=N. *dorsalis*, Ph., var. *β*., with an angular margin to the umbilicus; S. *latiseptatus* de Kon.; S. crassiventer, de Kon. (doubtful British); S. *cyclostomus* (Ph.); S. **conspicuus*, de Kon. (new to Britain); S. *pentagonus*, Sow.

Genus Nautilus.—Triassic—N. privatus, Mojs. [thus the earliest true Nautilus recognised is Triassic]; N. Suessi, Mojs; N. Sauperi, Hauer; N. Simonyi, Hauer; N. linearis (Münster); N. (Clydonautilus) spirolobus, Dittmar; N. (C.) Quenstedti, Hauer. Jurassic—N. *striatus*, Sow.; N. *intermedius*, Sow.; N. *simillimus, F. and C.; N. *araris*, Dum.; N. *truncatus*, Sow.; N. *astacoides*, Y. and B.; N. semistriatus, D'Orb.; N. toarcensis, D'Orb.; N. **Jourdani*, Dum.; N. **terebratus*, Dum. (new to Britain); N. *robustus, F. and C.; N. *Fischeranus, F. and C.;

N. **ornatus*, F. and C.; N. **lineatus*, Sow.; N. **pseudolineatus*, F. and C.; N. **polygonalis*, Sow.; N. **glaber*, F. and C.; N. **obesus*, Sow.; N. **inornatus*, D'Orb.; N. **multiseptatus*, F. and C.; N. *Baberi*, Morris and Lycett; N. *subtruncatus*, M. and L.; N. **clausus*, D'Orb.; N. **lineolatus*, F. and C.; N. **perinflatus*, F. and C.; N. *excavatus*, Sow.; N. **Smithi*, F. and C.; N. **Burtonensis*, F. and C.; N. **Calloviensis*, D'Orb.; N. *hexagonus*, Sow.; N. (Hercoglossa) aganiticus, Schl.; N. (H.) *franconicus, Opp.; N. (H.) *portlandicus*, F. and C. Cretaceous—N. *sublævigatus*, D'Orb.; N. *undulatus*, Sow.; N. *plicatus*, Fitton; N. *radiatus*, Sow.; N. *neocomiensis*, D'Orb.; N. *Deslongchampsianus*, D'Orb.; N. *pseudoelegans*, D'Orb.; N. *albensis*, D'Orb.; N. *Bouchardianus*, D'Orb.; N. *arcuatus*, Desh.; N. Kayeanus?, Blanf.; N. *triangularis*, Montf.; N. *Fleuriausianus*, D'Orb.; N. *Fittoni*, Sharpe; N. **elegans*, Sow., on which there is a long discussion; N. *elegantoides, D'Orb.; N. **semiundatus* (sp. nov.), inflated, umbilicus closed, with round margin, septa somewhat distant, with V-shaped rounded ribs on front in youth, U.G.S. [fig. 30]; N. *ventroplicatus* (sp. nov.), more compressed, with finer ribs and more flexuous sutures, U.G.S.; N. *cenomanensis?* Schlüter; N. *expansus*, Sow.; N. *Largilliertianus*, D'Orb.; N. *Clementinus*, D'Orb.; N. **cantabrigiensis* (sp. nov.), chambers few, shell umbilicated, septa sinuate, siphuncle extramedial, Cambridge G.S. [fig. 31]; N. **hunstantonensis*, F. and C.; N. *atlas*, Whit.; N. Sowerbyanus, D'Orb.; N. Huxleyanus, Blanford; N. **Bayfieldi*, F. and C.; N. vastus, Kner.; N. Heberti, Binkh.; N. sphæricus, Forbes; N. ahltenensis, Schlüter; N. *darupensis*, Schlüt. (new as British); N. quadrilineatus, Favre; N. bellerophon, Lundg.; N. Reussii, Fritsch; N. *libanoticus, F. and C., this shows the beaks on the ventral surface of the body chambers; N. Dekayi, Morton; N. D'Orbignyanus, Forbes; N. (Hercoglossa) **Sarbyi*, Morris; N. (H.) Lallierianus, D'Orb.; N. (H.) danicus, Schl.; N. (H.) trichinopolitensis, Blanf. Tertiary—N. *centralis*, Sow.; N. *regalis*, Sow.; N. *urbanus*, Sow.; N. *imperialis*, Sow.; N. *Sowerbyi*, Wetherell; N. ellipticus, Schafh.; N. macrocephalus, Schafh; N. Deluci, D'Arch.; N. Labechei, D'A. and H.; N. *Mokattamensis (sp. nov.), periphery narrower and aperture broader than N. imperialis; Eocene, Egypt; N. decipiens, Michelotti; N. Allioni, Mich.; N. *geelongensis (sp. nov.), like N. regalis, but more inflated, and sutures less flexuous, Tertiary, Geelong; N. (H.) **Cassinianus*, F. and C.; N. (H.) *ægyptiacus (sp. nov.), inflated, convex on side, periphery subangular, umbilicus closed, septa remote, sutures bilobed, Eocene, Cairo.

Genus Aturia.—Under this head there is a careful descrip-

tion of the siphuncle, which shows four layers—external calcareous (= "porous"), nacreous, internal calcareous, and yellow—corresponding to similar layers in Nautilus pompilius. In an old A. Parkinsoni, however, the siphuncle is not funnelled but simple. The species are A.**ziczac* (Sow.); *A. Charlesworthi*, Foord=N. ziczac of Charlesworth, 1837; A. *Parkinsoni* (Edw.); A. delphinus (Forbes); A. *aturi, Bast.; and var. australis, M'Coy.

Figures are then given, without names attached, as the species to which they belong can seldom be determined, of Rhyncholites from the Lias of Lyme Regis, the Gault of Folkestone, the Upper Greensand of Devizes, the Chalk of Kent and Sussex, the Cambridge Greensand, the Miocene of Malta, and in N. libanoticus *in situ*.

A supplement describes Orthoceras intermedium, Barr.; O. chinense, Foord; O. campanile, Mojs.; Actinoceras striatum? (Sow.); Huronia Portlocki, Stokes; Cyrtoceras (Meloceras) **impotens*, de Kon. (new to Britain), Ascoceras (giving the new information obtained by Lindström); Lituites lituus, Montf.; Pleuronautilus trinodosus, Mojs.; N. (Hercoglossa) Sauperi, Mojs.; and N. Saussureanus?, Pictet.

***336. Foord, A. H.—On some Cephalopoda from the Cross Fell Inlier. (Appendix II. to a Paper by Messrs. Nicholson and Marr.)**

Quart. Journ. Geol. Soc., vol. xlvii., p. 526.

Orthoceras cf. *elongatocinctum*, *O.*, sp., and *Cyrtoceras*, sp., are described, and the following new species, *O pusgillense*—tapering 1 in $7\frac{1}{2}$; septa shallow, $\frac{1}{8}$ diam. apart; siphuncle central; bulbous, bulbs $\frac{1}{4}$ diameter of shell; test smooth [fig. 32].

***337. Foord, A. H.—On** *Pleuronautilus (Nautilus) nodoso-carinatus*, **Römer, sp.**

Geol. Mag., Dec. 3, vol. viii., p. 481.

Gives a figure of this species from Caton, Lancs., and quotes Armstrong's description of *Nautilus nodiferus*, which is considered a synonym.

***338. Buckman, S. S.—A Monograph on the Inferior Oolite Ammonites of the British Islands. Part v., pp. 225–256, pls. xxxvii.–xliv.**

Palæontographical Society, vol. for 1890.

This commences with the *Arietidæ*, of which he founds a new genus, *Hudlestonia*, to include the three species *H. Sinon*, *H. affinis*, *H. serrodens*, all represented by poor specimens from the *Jurense* zone and Blea-Wyke Beds.[1]

[1] It is difficult to appreciate the reasons which have induced the author to place these amongst the *Arietidæ*, with which they appear to have little in common. They look like *Harpocerata* with simple sutures, but with the characteristic accessory lobe to the siphonal saddle.

The principal part is occupied by species of *Dumortieria*, which is referred to the family *Polymorphidæ*. This carinated, often fine-ribbed, genus is supposed to have descended from *C. vernosæ* of the Middle Lias, which has no keel, coarser ribbing, and less involution, the intermediate stages being unknown. Its history is said to differ from that of *Grammoceras*, by its not passing through an Arietan stage. Its ribs are nearly straight, and with only a slight ventral projection. The inner part of the suture line is "somewhat dependent—*i.e.*, the lobes pointing across the whorl towards the carina." The species described are *D. prisca* (n. sp.) [fig. 73], with evolute, circular whorls, feebly keeled, and with distant irregular straight ribs, from the *Jurense* zone (unique); *D costula*, Rein. [and the smaller specimen is figured with sigmoid ribs] ,*Jurense* zone; *D. sparsicosta*, Haug., not figured in this part, and said to show grammaceratoid sutures, *Opalinum* zone; *D. Levesquei*, D'Orb.; *D. striatulo-costata*, Quenst.—this resembles *G. Doerntense* when adult, but the young shows coarse ribs, *Jurense* and *Opalinum* zones; *D. pseudoradiosa*, Branco. (figured by J. Buckman, Q.J.G.S., as *A. Moorei*), *Jurense* zone; *D. radians*, Rein., from the *Jurense* zone and the "Upper Lias" of Down Cliff and var. *exigua*; *D. radiosa*, Seebach, from the *Jurense* and *Opalinum* zones; *D. radiosa*, var. *gundershofensis*, Haug., not figured in this part; *D. Moorei*, Lycett (description incomplete).

The plates contain also a figure of *Polyplectus discoides* and its sutures;[1] *Dumortieria arata*, n. sp. [fig. 74.][2]; *Catulloceras Dumortieri*, Thiollière; *C. Leesbergi*, Branco; *C. insigni-similis*, Brauns; and *D. subundulata*, Branco.

***339. Buckman, S. S.—Notes on Nautili and Ammonites.**

Proc. Geol. Soc., p. 165.

The author exhibited a series of six immature Nautili, and young Ammonites, in which the last septum was disproporately closer to the penultimate. This he regards as possible evidence of the power of a septum to grow forward in some way after its formation.[3] He also showed shell-muscle marks of Nautilus, to prove that the curvature of the inner edge and of their connecting ligament corresponds with the curvature of the septum. Also spatulate depressions on ammonite body-chambers which may be shell-muscle marks.

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[1] These do not agree with D'Orbigny's figure in the superior lateral lobe and, indeed, are drawn to show the differences.

[2] This is very arietan in aspect, and in the next part is referred to *Catalloceras*.

[3] As was pointed out at the reading of the paper, these examples may be exceptional. To prove the author's contention, they ought to be the rule, and this he has not shown them to be.

***340. Foord, A. H., and Crick, G. C.—Note on the Identity of *Nautilus neocomiensis*, Sharpe (non D'Orbigny), with *Nautilus Deslongchampsianus*, D'Orb.**

Geol. Mag., n.s., Dec. 3, vol. viii., p. 25.

Sharpe mentioned in his monograph of Chalk Mollusca (Pal. Soc.) that he had a specimen of *Nautilus neocomiensis* from the Grey Chalk, the usual horizon being Lower Greensand. This specimen is now in the British Museum, and shows longitudinal lines between the ribs, and in one part a keel near the umbilicus on each side, with raised longitudinal lines within, which characters show that it belongs to *N. Deslongchampsianus*.

GASTEROPODA.

341. Whidborne, G. F.—A Monograph of the Devonian Fauna of the South of England. Part III.—The Fauna of the Limestones of Lummaton, Wolborough, Chircombe Bridge, and Chudleigh. Pp. 155–250, pls. xvi.–xxiv.

Palæontographical Society for 1891.

This part commences the GASTEROPODA. Order PULMONATA; Fam. *Auriculidæ*.—*Dirhachis* (gen. nov.), which differs from *Plectotrema* in having a smooth outer lip and only two teeth on the inner lip. The only species, *D. atavus*, is not figured in this part. Whorls convex, last with 11 tuberculated ridges diminishing towards the base, lip crenulated within, no umbilicus; unique.

Order PROSOBRANCHIATA; Fam. *Pseudomelaniidæ*.—The forms described are *Macrocheilina subcostata*, Schl.; *M. arculata*, Schl.; *M. lincta*, Ph.; *M. imbricata*, Sow.; *M. subimbricata*, D'Orb.; *M. ventricosa*, Goldf.; *M. cf. acuta*, Sow.; *M. elevata* (n. sp.) [fig. 52], elongated, body whorl small, height $\frac{17}{8}$ of width; *M. ejecta* [fig. 53], new name for *P. fusiformis*, Goldf.; *M. cyclostoma*, n. sp., not figured in this part [and on turning to the reference in the part issued in 1892, the shell is found described as *Turbo inamictus*, so the present name is superseded]; *Loxonema Ræmeri*, Kayser; *L. nexile*, Sow.; *L. reticulatum*, Ph.; *L. scalariæforme*, Holz.; *L. conicum* (n. sp.) [fig. 70], very elongate, whorls flat, sutures shallow, base rapidly incurved, ornaments longitudinal riblets spirally reticulated, shell large; *L. priscum*, Münst.; *Michelia exaltata*, Römer?; *Spanionema* (gen. nov.), whorls almost wholly exposed, with a minute umbilicus, and discontinuous varices, shell very elongate; *S. scalaroides*, Whidb. [fig. 55].

Fam. *Littorinidæ*.—*Littorina devonica*, Whidb. [fig. 56], *L. Ussheri*, n. sp. [fig. 57], a short smooth-looking shell, with

only fine lines of growth, umbilicus covered with a callosity which has an indistinct central tooth, height $\frac{18}{11}$ the width. The author can find nothing to distinguish these from Littorinæ, though he admits they may not belong to that genus.

Fam. *Naticidæ.*—*Naticopsis harpula*, Sow.; *Natica nexicosta*, Ph.; *N. antiqua*, Goldf.; *N. meridionalis*, Ph.

Fam. *Velutinidæ.*—*Strophostylus*, sp.; *Platyostoma sigmoidale*, Ph.,—the author at first thought the two specimens figured to belong to distinct species; *P. deforme*, Sow.; *P. speciosum*, Sow.

Fam. *Capulidæ.*—*Capulus invictus*, n. sp. [fig. 58], spire almost flat; apex recurved; body whorl broad, almost keeled, a shallow groove below; ornaments flat spiral bands with white spiral grooves on a dark ground; may be a *Platyostoma; C. pericompsus*, n. sp. [fig. 59], has a very slow rate of increase, and distant apex, recurved umbo, body chamber subquadrangular, concave on one side; *C. rostratus*, Trenkner?, flatter and more curved than the next; *C. compressus*, Goldf., showing radial colour-bands; *C. puellaris*, n. sp. [fig. 60], trigonal; spire recurved, depressed, free, apex overhanging, swellings near the mouth; *C. terminalis*, n. sp. [fig. 61], differs from *C. columbinus* in its long and free and more tubular spire standing further from the mouth; *C. cordatus*, Whidb. [fig. 62]; *C. Ussheri*, n. sp. [fig. 63], specimen imperfect and description "tentative," curvature small, surface with sinuous growth lines, unique. *C. uncinatus*, Röm.; *C. columbinus*, Whidb. [fig. 64], subglobose, of great height, and with a minute recurved apex; *C. squamosus*, Trenkner?; *C. tylotus*, n. sp. [fig. 65], spire large, horizontally symmetrical, apex remote, surface expanding near the mouth, with occasional low tubercles; *C. galeritus*, n. sp. [fig. 66], like the last, but spire more regular and no expansion or tubercles; *C. contortus*, Röm.; *C. multiplicatus*, Giebel.[1] *Orthonychia costata*, Barrois; *O. quadrangularis*, n. sp. [fig. 67], a bell-shaped shell on an oblong base, wider than long [the width is measured in the plane of symmetry], apex over the mouth near the front.

Fam. *Scalaridæ.*—*Holopella tenuireticulata*, n. sp. [fig. 68], very elongate, with narrow whorls, surface very finely reticulated, suture line varying, height $\frac{30}{12}$ the width; *H. tenuisulcata*, Sandb.; *H. duplisulcata*, Whidb. [fig. 72], with minor striæ between the major; *H. Hennahiana*, Sow.; *H. costata*, Sandb.; *Scoliostoma texatum*, Münst.; *S. gracile*, Sandb. [The

[1] Are these species rightly referred to the recent genus *Capulus*? It is acknowledged that the characteristic muscular impression is not seen on the casts.

genus has a curious upward deflexion of the body whorl.] *Antitrochus*, gen. nov., turbiniform sinistral, sutures deep, mouth subcircular, peristome continuous, umbilicus minute. Ornamented spirally and longitudinally. *A. arietinus*, n. sp., [fig. 69], whorls very convex, ornaments 18—20 spiral lines on body chamber, crossed by backward sloping finer ones.

Fam. *Solariidæ*.—*Philoxene philosophus*, Whidb. [fig. 71], a large shell agglutinating fragments of other shells round its greatest convexity; *P. lævis*, D'Arch. and de Vern.; *P. serpens*, Ph.; *Euomphalus Dionysii*, Montf.; *E. Hecale*, Hall; *E. circularis*, Ph., and var. *gemmulifer*, with a beaded keel on the upper surface. [*Turbo Pengellii* is also figured [fig. 53], but not described in this part.]

***342. Newton, R. B.—On the Genus *Leveillia* (*Porcellia*, *Léveillé*) with a Notice of a New Species from the Carboniferous Limestone of Ireland.**

Geol. Mag., Dec. 3, vol. viii., p. 202, pl. vi.

He rejects the name *Porcellia*, because a genus of Isopoda has been previously called Porcellio,[1] and invents a new name instead. He accepts the now generally adopted reference of the genus to the *Prosobranchiata*, principally on Meek's ground, of the allied *Tremanotus* showing a series of siphonal openings like *Haliotis*. Two species are noted: 1. L. (*Porcellia*) Puzo, to which he refers Phillip's *Goniatites intercostalis*.[2] 2. L. latidorsata (sp. nov.) [fig. 33], of large size, dorsal region less convex and wider, with broad and prominent ribs over the back instead of the spirally beaded surface, broad nodules at the margins of the sides.[3] He enumerates three species from the Trias, nine from the Carboniferous, and 13 from the Devonian, four of which in all are British.

BRACHIOPODA.

343. Glass, N.—On *Athyris læviuscula*, Sow. sp., with the full Disclosure of its Loop, etc.

Geol. Mag., Dec. 3, vol. viii., p. 495.

The loop of this species has been worked out from specimens from the Tickwood Beds, Benthal Edge, and is described as follows: "It commences on the dorsal side of the spirals slightly above their centre, and consists of two short converging lamellæ, which arise from the primary lamellæ, and

[1] There really seems no danger of confusion here, for the Latins could distinguish between *Porca*, a ridge, and *Porcus*, a pig, or between *Pero*, a shoe, and *Pera*, a bag.

[2] One of the types of this species in the British Museum had a label on the back of the tablet in 1874 marked "Porcellia

[3] Might not these be old age characters ?

which proceed in an upward and sloping direction between the spirals and right across to their ventral side before uniting in a sharp point beneath the hook-shaped attachments to the hinge plate. Arising from this uniting point of the loop there is a bifurcation, the two accessory lamellæ thus formed curving in an upward and backward direction to the posterior border of the spiral." [The diagram given looks like two hockey sticks sloping inwards and crossing each other.] This is not the loop of an *Athyris*, and he refers the species instead to *Bifida*. Thus there is no British Silurian species of *Athyris* known.

***344. Wilson, E.—On a Specimen of *Waldheimia perforata* (Piette) Showing Original Colour Markings.**
Geol. Mag., Dec. 3, vol. viii., p. 458.

The specimen (figured) comes from the Lower Lias of Bitton, Glos., and the colour is arranged in irregular concentric bands now of black and white, similar on the two valves, and nearly coincident in their margins with the lines of growth.

345. Young, J.—On a Peculiar Structure, Spines within Spines, in Carboniferous Species of the Productidæ.
Trans. Geol. Soc. Glasgow, vol. ix., part i., p. 86.

In certain examples of *Productus scabriculus* from Polyzoan shale at Roscobie, Fife, the larger spines are found, on transverse section, to show throughout a narrow zone near the base a number of smaller microscopic spines, radiating inwards from the interior circumference. These would form an efficient filter for water passing inwards down the hollow spine, and as these communicate with the interior, the author considers the structure to support the idea that the spines are used as water channels. They occur also, less well preserved, in other spiny species.

POLYZOA.

***346. Vine, G. R.—Report of the Committee . . . appointed to prepare a Report on the Cretaceous Polyzoa.**
Rep. Brit. Assoc. for 1890, p. 378.

This is a summary of the species of Polyzoa which have been already recorded from Cretaceous rocks, with miscellaneous remarks. The rearrangement of D'Orbigny's species by E. Pergens in Bull. Soc. Belge Geol., tom. II., is first quoted, and then attention is drawn to A. W. Waters' recognition of Cretaceous species, now living in Australia, which the author neither denies nor confirms. He then considers the re-

corded 42 species from the Faringdon gravels, which are referred to forms belonging to seven different terrains from the Bajocian to the Danian. These he considers to be *remanié*, but he notes the abundance of the Cyclostomata which characterise all ages, and the rarity of the Chilostomata which commence only in the Cretaceous, and concludes that the materials have been probably derived and deposited before the time of the Upper Chalk, in which case the reference of nine species to the Senonian, and three to the Danian requires reconsideration. Only three Polyzoa have been recorded from the Gault, and these he cannot find.

The list of named species from the Cambridge Greensand he divides into 24 unattached, and 13 attached, and he notes that 13 of these occur also in the Chalk detritus.

Seventeen species are recorded from the Upper Greensand and four from the Blackdown and Haldon Beds.

Finally he gives a list of the species from the Red Chalk described last year [No. **451**, 1890], of which 17 are peculiar to this horizon, three being added, but only named, and 26 referable to species described elsewhere.

***347. Waters, A. W.—On Chilostomatous Characters in *Melicertitidæ* and other Fossil Bryozoa.**

Ann. Nat. Hist., ser. vi., vol. viii., p. 48, pl. vi.

Recent writers [No. **347**] have classed the Melicertitidæ, as of old, with the Cyclostomata. The author points out that the accessory cells are really avicularia, such as are found only in the Chilostomata, also the pores on the surface are larger than in the Cyclostomata, and there is a closure of the aperture, by a thin calcareous plate. In the interior of the zoecium there are two longitudinal curved plates which narrow the opening, at the base of which the peristome may be said to commence; all these points indicate a relationship to the Chilostomata, though the central axis of parallel plain tubes resemble the structure seen in many of the Cyclostomata.

He then describes and figures *M. royana*, sp. nov., which shows the avicularia, from Royan, near Bordeaux, and figures *M. semiclausa*, D'Orb.

***348. Vine, G. R.—Notes on the Polyzoa and Microzoa of the Red Chalk of Yorkshire and Norfolk.**

Proc. Yorkshire Geol. and Polyt. Soc., vol. xi., part iii., p. 363, with plate xvii.

This paper is first a *résumé* of a previous paper in the Quart. Journ. Geol. Soc., vol. xlvi., on the Red Chalk Polyzoa [*see* No. **451**, 1890]. It then records the following Entomostraca: *Bairdia subdeltoidea*, *B. Harrisiana*, *Cythereis auriculata*, *C. Lonsdaleana*, *Cytherella ovata*, and *C. Muensteri*.

It also records nine Foraminifera, all included in Sherborn and Burrows' longer list [No. 11, supplement for 1890].

The plate gives figures of six species of *Stomatopora* and two of *Diastopora*.

TRILOBITES.

349. Lapworth, C.—On *Olenellus Callavei* **and its Geological Relationships.**

Geol. Mag., Dec. 3, vol. viii., p. 529, pls. xiv., xv.

This is now completely described. One of the plates shows the fragments actually obtained, the other, a splendid piece of constructive palæontology, shows them all put together, so that the animal may be realised. The characters will be seen by the figure [fig. 34]. The principal are: Semi-elliptic form of the head, with fairly long genal spines. The "interocular" spines on each side, and the dorsal spine projecting backwards from the centre of the occipital ring. The subclavate 3—4 furrowed glabella. The semi-elliptic eye-lobes, with a projection next the glabella. The thorax, with 18 (?) segments, the centre of each with a recurved spine, less conspicuous on the last segments, pleuræ recurved. Pygidium, a small single semicircular piece. The surface covered by a raised network. Further on it is said there is no facial suture, but the fragmentary nature of the remains scarcely makes this certain. In these characters it agrees generally with the other species known to come from a similar horizon, and the group he had named *Cephalacanthus*, but appears willing to yield this for the sake of *Holmia*.[1] The fossils occur in purplish calcareous sandstone at Comley Quarry, Little Caradoc, below a conglomerate, and are associated with *Kutorgina cingulata*, and *Linnarsonia sagittalis*. From the conglomerates and associated limestones has been obtained a new species of *Paradoxides*, not figured; *P. Groomii* intermediate between *P. Harlani* and *P. Davidis*, genal spines, 2—3 in. long, glabella clavate, frontal lobe more than half of it, pleura falcate, pygidium with central tubercle, side spines sabre-like, diverging distally. The author points out that we have thus the three zones of *Olenus*, *Paradoxides*, and *Olenellus*,[2] in their proper order, and he suggests that for the latter we should use the term Taconian. We have thus every reason to believe that here is the true base of the Cambrian system. The author then draws attention to his deductions from this in 1888, when the occurrence of *Olenellus* was

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[1] Published by Mathews in America, June, 1890.

[2] Or shall we say *Holmia*?

first announced, and shows how they have been practically accepted or adopted on independent grounds.[1]

ENTOMOSTRACA.

***350. Jones, T. R.—Eighth Report of the Committee . . . on the Fossil Phyllopoda of the Palæozoic Rocks.**

Rep. Brit. Assoc. for 1890, p. 424.

Describes a provisional new species, *Saccocaris minor* [fig. 100], from the highest Arenig zone of Arenig Mountain. Carapace arched above, straight below, truncate behind, with a slight projection in the upper fourth, with five longitudinal lines, and with abdominal segments. The species is quoted as by "J[ones] and W"[oodward].

The Report mentions also an *Aristozoe* from the Devonian of France, the Scotch Carboniferous *Estheriæ* described in No. **352**, and a Devonian *Estheria* from America.

***351. Jones, T. R.—On some *Estheriæ* and *Estheria*-like Shells from the Carboniferous Shales of Western Scotland.**

Trans. Geol. Soc. Glasgow, vol. ix., pt. i., p. 79.

Describes three new species, viz., *Estheria Youngii*, Upper Carboniferous Limestone, Arden [fig. 95], characters given by figure; it has also fine longitudinal striæ; *E. tessellata*, Cannel Coal, Ayrshire [fig. 96]; some edge-views show a greater relative height; *E. tegulata*, Upper Coals, Airdrie [fig. 97], ornaments tile-like. It is not, he now finds, an *Estheriella*. Both of these last are found also distorted by pressure, and all three are non-calcareous. The fossils he formerly described as *E. punctatella* he now refers, in spite of their being non-calcareous and gregarious, to the mollusca as *Posidonomya*, which also shows similar punctation. One reason of this change appears to be that some larger specimens, of which these may be the young, are found to be calcareous at Thornliebank.

***352. Brockbank, Wm.—On the *Entomostraca* and *Annelida* in the Levenshulme Mottled Limestone.**

Mem. and Proc. Manchester Lit. and Phil. Soc., vol. iv., No. 2, p. 47.

This paper describes the microscopic appearance of a series of Upper Carboniferous Limestones at Levenshulme, the geological relations of which are described in **No. 104** as well as their general characters. The "fish-eye" spots are

[1] It should, however, be stated that the conclusions as to the pre-Cambrian age of the Longmynd and St. Lo series had been previously suggested.

the coprolitic; one in the fifth group of rocks shows remains of the food. The third group contains *Cypridina primæva*, *Cytherella* and *Spirorbis*. The fifth shows *Daphnia primæva*, with jointed tubular organisms which may be *Serpulæ*. The 6th contains shells and bone fragments, and the 7th shells and annelid tubes.

***353. Brockbank, W.—Supplementary Note on the *Annelida* and *Entomostraca* in the Levenshulme Limestones.**

Mem. and Proc. Manchester Lit. and Phil. Soc., vol. iv., p. 353.

Draws attention to the *Carboniæ* described by T. R. Jones and W. Kirby [No. **467**, 1890], and considers them indicative of estuarine habitats. There are also *Spirorbis ambiguus*, *S. pusillus*, *Serpulites carbonarius*, *Vermilia*, *Ortona carbonaria*, and *Ditrupa*. The Upper Coal-measures may by their means be recognised microscopically.

***354. Jones, T. R.—On some more Fossil Estheriæ.**

Geol., Mag., n.s., Dec. 3, vol. viii., p. 49.

The species noted or described are *Estheria membranacea* (Pacht), of which a figure was given in 1890 [No. **463**]. It shows the characteristic reticulation. *E. Andrewsii* (sp. nov.) [fig. 98], approximately quadrate or elongate, umbo less anterior, less curved antero-ventrally, higher behind than *E. subquadrata*. Interstitial ornament a delicate reticulation with larger pits inside. Black Purbeck Shale, Teffont-Ewyas, Wilts. *E. Hindei* (sp. nov., figured) longer, less semicircular ventrally than *E. ovata*, 15 strong concentric riblets, partial interstitial ornament. Trias Pennsylvania. *E. minuta*, Alberti [fig. 99], and var. *Brodieana*, which has now been found in the upper part of the Keuper Marls at Alderley Edge.[1]

Estheriella costata, Weiss, [figured]; *E. nodocostata* (Giebel).

ECHINOIDEA.

355. Gregory, J. W.—A Revision of the British Fossil Cainozoic Echinoidea.

Proc. Geol. Assoc., vol. xi., pt. 1, p. 16, and also in pt. 2, continued under the title "The British Tertiary Echinoid Faunas and their Affinities," pls. i., ii.

The principal museums containing these fossils are the British, Jermyn Street, Woodwardian, York, Norwich, Ipswich, and Saffron Walden.

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[1] The author says in "f 6" which he adds is below "f 5," but this is obviously a slip.

The following are described:—

I. Eocene; Fam. ARBACIDÆ. — *Cœlopleurus Wetherelli*, Forbes, Lond. Clay; *C. Dixoni*, n. sp., Bracklesham, Dixon Geol. Sussex, pl. ix., figs. 27, 29, differs from *C. Wetherelli* by its coarser tubercles, and from *C. spinosissimus* by its circular form, and smaller and more uniform tubercles; *Echinopedina Edwardsi* (Forbes), Bracklesham.

Fam. FIBULARIDÆ.—*Scutellina lenticularis* (Lam.), Bracklesham, new to Britain.

Fam. SPATANGIDÆ.—*Hemiaster Bowerbanki*, Forbes, L.C. It has been proposed to separate this and others, sometimes showing only two genital pores, as *Ditremaster*; but the number of such pores is not found to be even of specific value. *H. Prestwichi*, Forbes, L.C.; *H.? Branderi* (Forbes), Barton Clay; *H. Forbesi*, n. sp., L.C. [fig. 57], differs from *H. Bowerbanki* in the anterior margin being more hollowed out, in the lateral ambulacra being longer and more equal, and the posterior margin more vertical; *Schizaster d'Urbani*, Forbes, Bracklesham, whose deep anteal furrow shows it to have been viviparous; *S. Corneti* ?, Cott., Thanet Beds, new to Britain; *S. cuneatus* [fig. 48], n. sp., London Clay. Has a flat gradual anterior slope from the high carinate posterior end, ambulacra deeply impressed. *Maretia grignonensis* (Desm.), Barton (= *Omalii*); *Euspatangus* (= *Eupatagus*) *Hastingsiæ*, Forbes, Barton; *E. excentricus*, n. sp. [fig. 101], Barton, apex very excentric, one-third from the anterior margin, ambulacra flush.

II. Pliocene; Fam. CIDARIDÆ.—*Cidaris*, sp., Cor. Cr.

Fam. TEMNOPLEURIDÆ.—*Temnechinus*. This is considered as distinct from *Opechinus* (Indian), and both are transferred to the sub-family *Glyphocyphinæ*. *T. Woodi* (L. Ag.), Cor. and Red Cr. Most specimens have a depression on the summit of each interradius; these depressions are regarded as marsupial pouches, though such pouches hitherto known in the *Spatangidæ* are on the ambulacra. These specimens, called *T. excavatus* by Forbes, are, therefore, the female, and the others, called *T. melocactus* by Forbes, are the male of *T. Woodi*—the other point of distinction—the relative width of ambulacraand interradii being found to be variable; *T. globosus*, Forbes, Cor. Cr.

Fam. ECHINIDÆ.—*Echinus Woodwardi*, Desor., all the Crags; *E. esculentus*, L., Cor., and Chillesford Crag; new as Pliocene; *E. miliaris*, P.L.S., Müller, Cor. and Red Crag; *E. Woodi*, Desor., Cor. Cr.; *E. Lyelli*, Forbes, Cor. Cr.; *E. Charlesworthi*, Forbes, Cor. Cr.; *E. Henslowi*, Forbes, Red Crag; *E. spheroideus*, Cott., Red Crag, new to Britain; *E. paucimiliaris*, Gregory, Red Crag.

Fam. ECHINOMETRIDÆ.—*Strongylocentrotus drobachiensis* (O.F. Müller), Cor. Cr., new to Pliocene; *S. scaber*, Gregory, Cor. Cr.

Fam. FIBULARIDÆ.—*Echinocyamus pusillus* (O. F. Müller),

all the Crags. This includes all the species separated by Forbes. *Rhynchopygus Woodi* (Forbes), Cor. and Red Cr.; *Echinolampas* (genus new to Britain) *subrostatus*, n. sp. [fig. 49], Cor. Cr., comparatively narrow, apex excentric; *Agassizia* (genus new to Britain) *æquipetala*, n. sp., Cor. Cr. [fig. 50], more depressed than *A. excentrica*, and with the petaloid portions of the ambulacra nearly equal in length, and flush with the test; *Brissus unicolor* (Leske), Cor. Cr.; *Spatangus purpureus*, O. F. Müller, Cor., Red. and Chillesford Crags; *Echinocardium cordatum* (Penn), Cor., Red, and Chillesford Crags.

III. Pleistocene; Fam. ECHINIDÆ.—*Echinus esculentus*, L.; *E. Woodwardi*, Desor. Fam. ECHINOMETRIDÆ.—*Strongylocentrotus drobachiensis* (O. F. Müller). Fam. SPATANGIDÆ.—*Echinocardium*, sp.

IV. Post-Glacial; Fam. ECHINIDÆ.—*Echinus esculentus*, L.; *E. miliaris*, P.L.S. Müller. Fam. FIBULARIDÆ.—*Echinocyamus pusillus* (O. F. Müller). Fam. SPATANGIDÆ.—*Spatangus purpureus*, O. F. Müller, *Echinocardium*, sp.

The small number of these forms is due to the unsuitability of the conditions, and it is rather to causes of this kind that the great difference between them and the Upper Chalk Echinoderms is due—a difference not so marked between the Lower Chalk and Tertiary forms.

The Echinoidea point, as other forms of life have done, to barriers in the early Eocene times limiting the London area, which were breached in the Middle Eocene period, whose fauna has greater relations to the Southern.

The Pliocene Echinoids are less related, now we know them better, to the recent Mediterranean forms than had been supposed—but they are still less related to the Mediterranean Pliocene forms.

The general facies of the fauna is the same as that in Belgium, though the species are mostly distinct. The five species, *Temnechinus Woodi*, *T. globosus*, *Rhynchopygus Woodi*, *Agassizia æquipetala* and *Echinolampas subrostrata* are distinctly tropical American; as these are absent from Belgium, the migration was probably from the west. These genera do not occur in the West Indian Miocene—but as they are found on both sides of the Panama isthmus they must have arrived there before its elevation—yet early enough for them to have now developed distinct species, and they cannot therefore have entered later than the Pliocene. The view that there has been a shallow ridge connecting America and Europe is preferred to the idea of a migration round the northern shores —as a similar resemblance of fauna in Miocene and recent times has to be accounted for, and some of the migrants are found in Madeira and the Azores.

A Bibliography is appended to this paper.

356. Gregory, J. W.—A Catalogue of the Pliocene Echinoidea in the Reid Collection in the Museum of the Yorkshire Philosophical Society.

Ann. Rep. Yorkshire Phil. Soc. for 1890, with a plate.

The species here recorded are *Temnechinus Woodi* (Ag.); *Echinus Woodwardi* (Desor.); *E. esculentus*, L.; *E. miliaris;* Müller; *E. Charlesworthi*, Forbes; *E. paucimiliaris*, spec. nov. [fig. 102], Red Crag, like *E. miliaris*, but the interradii have a large tubercle on each side of each area, and, except at the very summit, another on each side, making four; *E. Woodi*, Desor.; E. *Henslowi*, Forbes, with hollows in the summit of each interradius, possibly indicating a female; *E. sphæroideus* (Cott.), new to Britain; *Strongylocentrotus scaber*, spec. nov., Cor. Crag [fig. 103], has a large apical system. Pores in six pairs, ambulacral plates 8 or 9, tubercles large, interradial plates 6 or 7, a row of large tubercles on each side, and secondary tubercles; *Echinocyamus pusillus* (Müller); *Spatangus purpureus* (Müller); *Brissus unicolor* (Leske); *Echinocardium cordatum*, Pennant.

357. Roberts, T.—On Two Abnormal Cretaceous Echinoids (Woodwardian Museum Notes).

Geol. Mag., Dec. 3, vol. viii., p. 116.

One of these is an *Echinoconus subrotundus* which has only four ambulacral and interambulacral areas, one on the left side being wanting; all eight are perforated apically, and a pentagonal "madreporite plate" is figured, but not referred to. The other is *Peltastes Wrightii*, which has an apical disc showing 12 plates, a supplementary one being interposed between the madreporic plate and the centro-dorsal.

ASTEROIDEA.

***358. Sladen, W. Percy.—A Monograph of the British Fossil Echinodermata from the Cretaceous Formations. Vol. ii. The Asteroidea. Pp. 1—28, pls. i.—viii.**

Palæontographical Society for 1890.

The fossils described in this part all belong to the subclass Euasteroidea, Order Phanerozonia, Family *Pentagonasteridæ*. They have hitherto been almost all described under the names *Goniaster* and *Astrogonium*, which have been incorrectly applied.

The *Pentagonasteridæ* are defined as "Phanerozonate asterids, with thick and massive marginal plates, which may be either naked, or bear granules or spiniform papillæ. Disk largely developed, apical plates often increscent, abactinal surface tessellate, with rounded, polygonal or stellate plates, which may be tabulate or paxilliform. Actinal interradial areas

largely developed, covered with pavement-like plates, which may be naked or covered with membrane, or may bear granules or spinelets." The sub-family here dealt with is the *Pentagonasterinæ* which have "the abactinal area paved with rounded, polygonal, or paxilliform plates. Granules or spinelets, when present, co-ordinated." Three species—*C. Smithiæ* (Forbes), *C. mosaicum* (Forbes), and *C. latum* (Forbes)—are now referred to the genus *Calliderma*, Gray, which has the disk large and flat, the rays moderately elongated and tapering, the marginal plates granulated, the abactinal area with small regularly arranged plates, hexagonal in the radial areas, bearing co-ordinated granules. Actinal interradial areas large, confined to the disk, with large, granulated intermediate plates. Armature of adambulacral plates arranged in longitudinal series. The genus *Nymphaster* differs from the above in having the rays elongate, slender, and almost square in section, marginal plates either united along the median abactinal line of the ray throughout, or separated only by a single series of medio-radial plates. Abactinal plates large. It includes *N. Coombii* (Forbes), *N. marginatus* (n. sp.) [fig. 47] (B. M. 35,484). In this the rays have a narrower base, the disk area is much more contracted, and has fewer marginal plates, all these are shorter, broader, and ornamented with isolated pits instead of a reticulation. A second new species, *N. oligoplax* [fig. 46] (B.M. 40,178), has the rays narrow at the base, and the interbrachial areas wider. The marginal plates, which are low, flat, and nearly square, show small punctations, and support pedicellariæ. *P. angustatus* (Forbes) is placed in a new genus, *Pycnaster*, which has a small high disk, massive convex marginal plates; uniting along the middle line of the ray, large actinal intermediate plates, and elongate narrow robust rays. (It is figured in the succeeding vol.) To the genus *Pentagonaster* are referred *P. lunatus* (Woodward) and *P. megaloplax* (n. sp.) description unfinished. The major radius in this is 1½ times the minor; in the other species it is twice as long. The infero-marginal plates are 12 from ray point to ray point instead of 24, and form a broader, more uniform border. The actinal interradial areas have larger plates. The illustrative figures are exceptionally beautiful.

PELMATOZOA.

359. Carpenter, P. H.—Notes on the Morphology of the Cystidea.

Rep. Brit. Assoc. for 1890, p. 821.

The plates in the lower part of the body of some Cystidea

may be interpreted homologously with those of the Crinoidea. Thus in *Caryocrinus* there are four plates, two of which are double, resting on the stem; these are "infrabasal," the next alternating row of six are "basals," and above are six alternating, which are "radials," and two others which are "interradial." In the same way the plates of *Hemicosmites*, *Protocrinites*, *Porocrinus*, and *Echinoencrinus*, and several others, may be interpreted. The mouth was protected by five or six oral plates. The "hydrophores palmés" of Barrande are not at the dorsal pole, but are remains of subtegminal ambulacra. In the absence of a genital pore, the anal pyramid may have subserved the purpose. The fourth opening near the peristome of *Aristocystis* may have been nephridial, as may have been also the third opening in *Echinoencrinus*.

***360. Bather, F. A.—British Fossil Crinoids, IV.** *Thenarocrinus gracilis*, **sp. nov., Wenlock Limestone, and Note on** *T. callipygus.*

Ann. Nat. Hist., ser. vi., vol. vii., p. 35, pl. i.

Another specimen of *T. callipygus* shows the anal area more completely; it agrees with the author's former diagram. Small differences are noted, and the three known specimens are figured.

T. gracilis [fig. 104] is from Dudley. Cup conical, rather elongate, plates mostly higher than wide; arms about six times the length of cup, slender, dichotomising five times; arm-ossicles, when seen from the back, about as high as wide, lateral compression very slight; anal plates low in the cup; stem (so far as known) smooth. The diagnosis of the genus is altered by this species by the substitution of "R′ in basal circlet, resting on *one or more* post. I B" for "R′ in basal circlet, resting on *r.* post I B." [*See* No. **472**, 1890.]

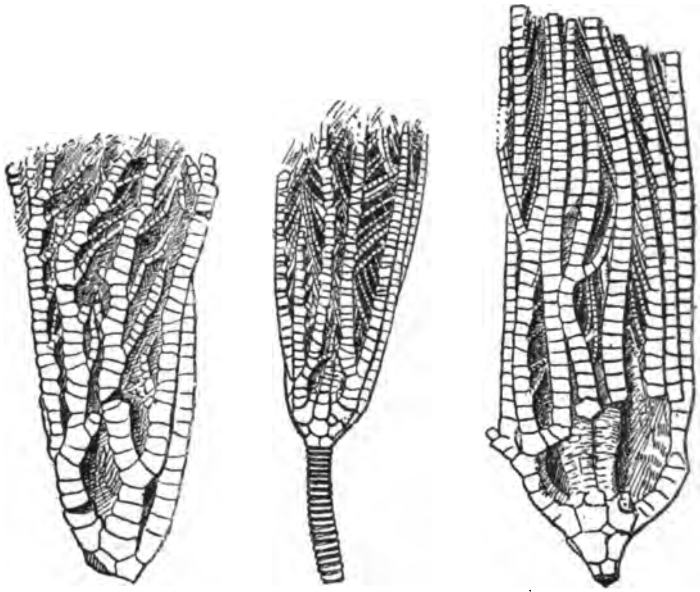
***361. Bather, F. A.—British Fossil Crinoids, V.** *Botryocrinus*, **Wenlock Limestone.**

Ann. Nat. Hist., ser. vi., vol. vii., p. 389, pl. xiii.

The genus *Botryocrinus* was founded by Angelin, whose diagnosis is translated into "modern terminology,"[1] by the substitution of "infrabasal" for "basal," "basal" for "parabasal," "costal" for second "radial," and "x" for anal, &c. With this genus he unites *Sicyocrinus* of the same author, and modifies the diagnosis accordingly. Three British species are described:—1. *B. ramosus*, sp. nov. [fig. A]; it has irregular arms and armlets, and the cup broad at the base, median proximal plate of the ventral sac large and high, arm-ossicles beaded. 2. *B. decadactylus*, sp. nov. [fig. B]. This, however,

[1] This does not appear to correspond in some of the terms with that of P. H. Carpenter, 1890 (*see* No. **473**, 1890, where for "supra-" read "infrabasal."). It is to be hoped that all Crinologists do not use the word "infrabasal," which is about as logical as the "ultrabasic" of the Petrologists.

includes the imperfectly defined *Cyathocrinus decadactylus*, Salter, with which he unites *C. quindecimalis*, Salter. This is the commonest form. It has the cup with a narrow base rapidly widening above, and pinnulate arms. 3. *B. pinnulatus*, sp. nov. [fig. C], differs from the last in the longer and straighter arms and fineness of the pinnules, and less ridged ventral sac. The type specimen shows abnormalities of arm-branching.



A. B. C.

362. Carpenter, P. H.—On Certain Points in the Morphology of the *Cystidea.*

Journ. Linnean Soc. Zoology, vol. xxiv., pp. 1—52, pl. i.

A very detailed paper discussing the proper naming of the plates forming the dorsal cup in *Hemicosmites*, *Caryocrinus*, *Caryocystis*, *Echinoencrinus*, *Apiocystis*, *Lepadocrinus*, *Pseudocrinus*, *Glyptocystis*, *Hypocrinus*, and *Cryptocrinus*, from which he concludes "that many cystideans have a calycular system which is essentially similar to that of the crinoids, and "that there are a considerable number of cystids which are characterised by the possession of a dicyclic calyx, like that of crinoid, and that these may be grouped round two central forms—*Caryocrinus* with hexagonal symmetry, and *Echinoencrinus* which is pentamerous, with the two infrabasals of the anal side united into one large plate." He next discusses

the nature and functions of the summit openings in *Caryocrinus*, *Juglandocrinus*, *Hemicosmites*, *Pyrocystis*, *Glyptosphæra*, *Aristocystis*, *Hymenaster*, and others; and concludes by some general considerations dealing with the origin of the Cystids. In a long postscript he discusses some points connected with the dorso-central system, the water-vascular system and its relations, and the oscular orifice.

CORALS.

363. Young, J.—On the Internal Structure of the Carboniferous Corals forming the Genus *Chætetes* of Fischer.

Trans. Geol. Soc., Glasgow, vol. ix., part i., p. 57.

J. Thomson has asserted the existence of mural pores, like those in *Favosites*, in the walls of *Chætetes*, but this has been denied by H. A. Nicholson. The author, after an examination of 100 specimens in various states of preservation, has been unable to see any, though some siliceous incrustations produce a similar appearance. He has found, however, on both walls and tabulæ a new structure, viz., some short, hollow spines, oblique to the walls, and perpendicular to the tabulæ. These are best preserved in specimens from the shales, and in the latest-formed portions of the coral. This last fact shows that their destruction must have taken place during the lifetime of the animal; the subsequent silicification has obliterated most of the structures—even some of the tabulæ; hence he concludes that all belong to one species, *C. septosus*, Flem. Some parts are also temporarily encrusted by other growths, one of which resembles *Girvanella*.

AMORPHOZOA.

364. Nicholson, H. A.—A Monograph of the British Stromatoporoids. Part III., pp. 159–202, pls. xx.-xxv.

Palæontographical Society for 1891.

This part commences with the species of *Labechia*. *L. conferta* occurs as laminar expansions with a tubercular surface. The tubercles are the terminations of vertical pillars, irregularly arranged, with an axial canal, and connected one with the other by vesicular tissue; Silurian only. *L. scabiosa*, n. sp. [fig. 45]. Unique, with tubercles large, more remote, and commonly multiple. *L. stylophora*, n. sp. [fig. 43]. The pillars are disposed concentrically in cylinders, and constantly diverge towards the outside of them, vesicular tissue very delicate; Devonian. *L. serotina*. Unique, pillars

forming a network, with large axial canals with internal partitions; intervening tissue fibrous or platy; Devonian. *L. canadensis*. Unique, only sections of large vesicles seen on polished surface; pillars probably destroyed; Ordovician.

The family *Stromatoporidæ* contains *S. concentrica*, which has undulating "latilaminæ," and reticulate structure, with zooidal tubes. There are three varieties, according as the "astrorhizæ" are small, superimposed in cylinders, or large. They are often found perforated by "caunopora tubes." Devonian only. *S. typica*, v. Rosen; Silurian. *S. Carteri*, n. sp. [fig. 40], massive, latilaminæ of a single layer, vertical pillars conspicuous, tissue very loose and open, no astrorhizæ seen; Wenlock. *S. Hupschii*, Bargatozky; *S. inæqualis*, n. sp. [fig. 42], like the last, but has two systems of astrorhizæ, a larger set and a smaller; *S. florigera*, n. sp. [fig. 44], also generally similar, but the skeleton-fibre is more delicate, and the astrorhizæ are smaller, more numerous, and vertically superposed; *S. Benthii*, Barg.; *S. Bucheliensis*, Barg.; *S. discoidea*, Lonsd.; *Parallelopora Goldfussii*, Barg.; *P. capitata*, Goldf.; *P. dartingtonensis*, Carter [fig. 41], cænosteum laminar or massive, astrorhizæ large and vertically developed, radial pillars distinct, connecting processes regular and slender.

FORAMINIFERA.

*365. Crick, W. D., and Sherborn, C. D.—On some Liassic Foraminifera from Northamptonshire. With a Plate.

Journ. Northamptonshire Nat. Hist. Soc., vol. vi., p. 208.

The fossils are from the Capricornus beds near Welton station. The ordinary fossils are the following:—

Am. margaritatus.	Plicatula lævigata.
—— Engelhardti.	———— spinosa.
—— trivialis.	Monotis inæquivalvis.
—— Valdani.	——— cygnipes.
Turbo cyclostoma.	Perna infraliassica.
Cryptænia consobrina.	Inoceramus substriatus.
Ostrea obliquata.	Cardita multicosta.
Pecten lunularis.	Protocardium truncatum.
——— æquivalvis.	Goniomya literata.
Limea acuticosta.	Pleuromya costata.

The Microzoa are washed from the sandy beds, and include *Bairdia liassica*, *Cytherella crepidula*, *Polycope cerasia*. The Foraminifera are:—

Ammodiscus incertus.	Cristellaria prima.
Glandulina humilis.	———— recta.
———— lævigata.	———— bacularis.
Lingulina tenera.	———— protracta.
Nodosaria radicula.	———— gladius.
———— annulata.	———— crepidula.

Nodosaria raphanistrum.	Cristellaria gibba.
——— mutabilis.	——— acutauricularis.
——— raphanus.	——— lata.
Dentalina pauperata.	——— varians.
——— communis.	——— rotulata.
——— mucronata.	——— costata.
——— multicostata.	Frondicularia Terquemi.
Marginulina raphanus.	——— intumescens.
——— costata.	——— sulcata.
Vaginulina legumen.	——— rugosa.
——— Bronni.	——— delirata.
Cristellaria deperdita.	Polymorphina fusiformis.

All of these are figured. *Frondicularia rugosa* [fig. 35] is a new species—"a large coarse form with approximately parallel irregular lamelliform costæ and marginal keels." *F. delirata* [fig. 36] is also new; the test is ploughed with divergent furrows.

***366. Chapman, F.—The Foraminifera of the Gault of Folkestone, I.**

Journ. Roy. Micr. Soc., vol. for 1891, p. 565, with pl. ix.

The author has worked out the Microzoa of the Gault by the zones of F. G. H. Price, washing the clay and examining the residues.

Zone I.—(*a*) The greensand seam. Residue 33 per cent., contains *Nubecularia nodulosa* (α[1]); *Anomalina ammonoides* (β), and prisms bored by parasitic plants; (*b*), Residue 1½ per cent.; *Bolivina textularoides* (γ); *Globigerina cretacea* (δ) and β.

Zone II.—(*a*) Residue 12½ per cent., γ, δ and β; (*b*) Residue 4 per cent. β; (*c*) Residue 6½ per cent., Ostracoda and δ.

Zone III.—Residue 5 per cent., yielding 26·61 of ferrous oxide; *Textularia pygmæa* (ε), γ, δ and β, Ostracoda abundant.

Zone IV.—Residue 1¾ per cent., *Lagena levis*, δ and β.

Zone V.—Residue 4½ per cent., Ostracoda, and ε, γ, δ and β.

Zone VI.—Residue 7 per cent. *Rotalia spinulifera* (ζ), *Lagena hispida*, δ and β.

Zone VII.—Residue 6¾ per cent. ζ, *Nodosaria simplex*, δ and β.

Zone VIII.—Residue 4¾ per cent., ζ, δ and β.

Zone IX.—Residue 2¾ per cent. ε, γ, *Nodosaria Jonesi*, δ and β.

Zone X.—Residue 8½ per cent. ε, γ, δ and β.

Zone XI.—(*a*) Residue 5 per cent. ε, *Ramulina globulifera* (η), δ and β; (*b*) Contains 40·39 of $CaCO_3$, Residue 1½ per cent., *Miliolina venusta*, ε, *Dentalina catenula* (θ) *D. communis* (ι), δ and β; (*c*) Residue 3 per cent. α, β, ε, *Lagena apiculata*, *Lingulina semiornata*, *Ramulina aculeata*, *Spirillina vivipara* and β; (*d*) Residue 1 per cent., laminated, θ, ε, *Textularia conica*, γ, ι, η, δ and β; (*e*) Residue 2½ per

[1] These letters are used afterwards in this abstract instead of the names, to save repetition.

cent., coprolites and boring plants, ϵ, *Textularia gramen*, γ, η, δ, and β; (*f*) Residue 1 per cent., small coprolites and boring plants, ϵ, δ and β.

The porcellanous foraminifera are then described and figured, viz., *Nubecularia depressa* (sp. nov.) [fig. 57], six or more flask-shaped chambers, disposed in a curved line, depressed and adherent, test porcellanous; at the junction of the last two chambers the stoloniferous tube divides, zone xi. *Nubecularia nodulosa* (sp. nov.) [fig. 38], free growing, rectilinear, nodulous chambers united by slender stoloniferous tubes, aperture simple, allied to *N. divaricata*, Brady, zones iv., v., x., xi. *Biloculina undulata* (sp. nov.) [fig. 39], resembles *B. depressa*, D'Orb., but both surfaces of the test are ornamented with concentric undulating ridges, zone xi.; *Spiroloculina asperula*, Karrer, zone xi.; *Miliolina venusta*, Karrer, zones x., xi.; *M. agglutinans*, D'Orb., zone xi.; *M. Ferrussacii*, D'Orb., zone xi.; *M. tricarinata*, D'Orb., zone xi.; *Ophthalmidium tumidulum*, Brady, zones iv., xi.; *Cornuspira cretacea*, Reuss, zones iii., iv., ix., x., xi.; *C. involvens*, Reuss, zones iii., v., vi., xi.; *C. foliacea*, Philippi, zones iv. xi.

367. Bailey, G.—The Tenants of a Fossil Echinus.

Proc. and Trans. Croydon Micr. and N. H. Club, p. 253.

A *Micraster* from the Chalk at Farningham Road has yielded:—

Textularia agglutinans.	Bigenerina capreolus.
——— baudoniana.	Spiroplecta biformis.
——— globosa.	——— rotula
——— sagittula.	Verneuilina triquetra.
——— trochus.	Bulimina presli.
——— turris.	Globigerina cretacea.
Lagena apiculata.	——— bulloides.
——— globosa.	——— Linneana.
——— sulcata.	——— marginalis.
Frondicularia Cordai.	Sphæroidina bulloides.
Vaginulina legumen.	Truncatulina lobatula.
Cristellaria crepidula.	——— Muellerstorfi.
——— cultrata.	Anomalina ammonoides.
——— rotulata.	Ramulina aculeata.
——— variabilis.	

***368. Sherborn, C. D., and Burrows, H. W.—Report on the Microscopical Examination of some Samples of London Clay, from the Excavations for widening of Cannon Street Railway Bridge, London, 1887.**

Proc. Geol. Assoc., vol. xii., pt. i., p. 4.

These samples came from 24 separate feet of depth, in a cylindrical hole, and the distribution of the various specimens in each is recorded. The residues, after washing, varied from ·03 to ·37 per cent. of the whole, and consisted either of sharp sand or woody fragments, but seldom of both together.

The following is the list of the Foraminifera, those new to London Clay being in italics :—

Miliolina circularis.	Marginulina glabra.
——— *tricarinata*.	Cristellaria cultrata.
——— trigonula.	——— rotulata.
Textularia agglutinans.	Polymorphina gibba.
Bigenerina capreolus.	——— gutta.
Verneuilina tricarinata.	Globigerina bulloides.
Lagena globosa.	Orbulina universa.
——— lævis.	*Pullenia quinqueloba*.
——— sulcata.	Discorbina *vesicularis*.
——— *gracilis*.	——— rosacea.
Glandulina *lævigata*.	——— *rugosa*.
——— abbreviata.	Truncatulina lobatula.
——— obtusissima.	——— *Dutemplii*.
Nodosaria humilis.	Planorbulina complanata.
——— radicula.	——— Haidingeri.
Dentalina communis.	Anomalina grosserugata.
——— abnormis.	Pulvinulina Boueana.
——— adolphina.	*Nonionina turgida*.
——— inornata.	——— *pompilioides*.

Cytheridea perforata and *Krithe londinensis* were also found.

MISCELLANEOUS.

***369. Hinde, G. J.—Discovery of Chert containtaining Radiolaria, &c., in the Palæozoic Rocks.**
Proc. and Trans. Croydon Micr. and N. H. Club, p. 253.

The briefest possible notice [*see* No. **478**, 1890].

370. Charlesworth, E. — On the Enigmatical Flint Bodies bearing the Name of Paramoudra.
Journ. Victoria Inst., vol. xxiv.

Gives an account of the discovery and discussion of the origin of these bodies. He objects to their being sponges, that they show no organic structure, that they are on this hypothesis always adult, and that no explanation is given of a green-coloured tube of chalk in the midst of the core.[1]

PALÆOBOTANY.

***371. Williamson, W. C.—On the Organisation of the Fossil Plants of the Coal-Measures, part xvii.**
Phil. Trans., vol. clxxxi. B., p. 89, with pls. 12—15. [*See* No. **478**, 1890.]

The stem called *Lyginodendron Oldhamium* shows a central medulla, then an exogenous xylem zone, then an inner cortex of thin-walled parenchymatous cells with scattered gum canals, and then an outermost cortex with radiating

[1] There seems no difficulty in supposing that there was no *preservable* structure, and that their skin only became tough enough to retain its shape when they were adult.

bands of sclerenchyma alternating with parenchymatous areas; between the two latter are seen pairs of vascular bundles characteristic of the cortex, and further out a pair of bundles of tracheids like those forming the centre of the cortical structure in *Rhachiopteris aspera.* The first pairs pass outwards in other sections into the second pair; outside all this are found on the surface numerous peculiar appendages, internally parenchymatous, but with an external layer of prosenchyma. These "emergences" are also highly characteristic of the petioles of *Rhachiopteris aspera.* From these similarities it is concluded that the latter are really the fronds of *Lyginodendron*, in which case a true fern is supplied with exogenous xylem produced by a cambium layer.[1]

The growth of the medulla in this stem is next traced. At first, as the branch is bursting through the cortex of the parent stem, it has a solid cluster of barred tracheæ in the centre, but on growth this splits up into several clusters, clinging to the inside of the xylem cylinder, the centre being occupied by a perfectly-developed parenchymatous medulla; as the xylem cylinder increases, these tracheal clusters become separated, so as not to occupy more than one-third of the internal circumference. This all shows a growth of the medulla from an invisible size to an inch in diameter. The number of vascular laminæ of the xylem zone, which start from the medulla, increases with the size of the stem from 44 to 1,120, the number of laminæ at the outer margin of the zone being constantly greater than this. Such an intercalation of new laminæ starting from the medulla "has no parallel amongst living plants."

Sections of the stem of *Heterangium tilæoides* from Fifeshire are then described. In transverse section it shows numerous clusters of tracheæ mingled with cells, and aggregated into a large axial mass. In the longitudinal section the centre is figured as occupied by this "vasculo-medullary axis" of barred tracheæ and cells. Outside this is the thick cortex, consisting first of rather regular vertical rows of cells, then of a band of very different aspect, with undulating vertical lines of cells, through which pass, at intervals, transversely disposed, spindle-shaped masses of very strongly-defined cells, projecting inwards and outwards. The surface is composed of a layer of fine sclerous fibres.

A section of the stem of *Bowmannites Dawsoni* with a triradiate vascular axis is given, showing that this fruit, *Sphenophyllum*, and some *Asterophyllites* have their stems of the same structure though they may differ in their leaves and fructification.

The fluted casts representing the central axes of true

[1] Actual demonstration of this has since been obtained.

Calamites are very seldom found of small diameter. The cause of this is that in young stems there is still left a layer of medullary parenchyma within the zone of projecting vascular wedges, which prevents the latter impressing themselves on the surface of the internal cast, and thus producing the vertical flutings.

***372. Cash, W., and Lomax, J.—On** *Lepidophloios* **and** *Lepidodendron.*

Rep. Brit. Assoc. for 1890, p. 810, and Proc. Yorkshire Geol. and Polyt. Soc., vol. xi., pt. iii., p. 478.

The genera *Lepidophloios* and *Lepidodendron* are easily distinguished by external characters. In the latter, the leaf cushions are fusiform or quadrate, and the leaf scar is generally above the centre of the cushion and has three punctiform cicatricules, the two lateral probably glandular. The cones are either at the ends of the branches, or in two opposite vertical rows. In the former, the leaf cushions are rhomboidal or elongate-truncate, with the leaf scar at the end, also with three cicatricules. The cones are borne on specially modified branches, and are arranged in spirals. In internal structure, however, they are closely allied, and species of *Lepidophloios*, *e.g.*, *L. brevifolium*, are intermediate in structure between *Lepidodrendron Harcourti* and *L. vasculare.* Its primary xylem has the same structure as in these, though it has not a crenulated outline, and it agrees with them also in the massive secondary xylem. The authors have lately acquired a specimen whose external characters are those above defined for *Lepidophloios*, but whose internal structure is identical with that of *Lepidodendron fuliginosum*, Will. The primary xylem has a slightly crenulated outline, and is a thin hollow cylinder with pith. This is followed by secondary xylem and cortex closely resembling those of the above species.

***373. Kidston, R.—On the Fructification and Internal Structure of Carboniferous Ferns in their Relation to those of Existing Genera with Special Reference to British Palæozoic Species.**

Trans. Geol. Soc. Glasgow, vol. ix., pp. 1–56, pls. i.–iv.

Section I. gives the fern-structure of existing species. *Filicaceæ* are divided into Leptosporangiate with annulate sporangia, and Eusporangiate with exannulate sporangia.[1] The first group is divided into Homosporous and Heterosporous, the latter not usually classed as Ferns, but as *Salvinaceæ* and *Marsilaceæ*, and not represented in the Carboniferous Flora. The homosporous *Filicaceæ* are divided by the characters of their sporangia into six families—the *Hymenophyllaceæ*, *Cyathaceæ*,

[1] F. O. Bower (*see* No. **379**) points out that this statement is not universally true, as the Leptosporangiate Hydropterideæ are exannulate.

Polypodiaceæ, *Gleichenaceæ*, *Osmundaceæ*, and *Schizaceæ*, all illustrated by figures. The Eusporangiate Filicaceæ are divided into *Ophioglossaceæ*, not represented in the Coal Flora, and *Marrattiaceæ*, whose sporangia are mostly united into synangia, particulars of five of which are given, with four illustrations.

Fern fronds are really dichotomies throughout. When by the suppression of alternate branches an apparently straight stem is produced it is a *sympodial* dichotomy; when the suppression is always on the same side, the stem curves and the dichotomy is *bostrychoid*; if neither are suppressed the dichotomy is *cicinnal*. This latter form is much commoner in Carboniferous ferns than in recent, especially amongst the so-called Sphenopteroids. The genera *Diplothmema* and *Mariopteris* have been founded on variations of this ramification. The venation in recent forms is either dichotomous or net-like—but does not serve for generic distinction, but in fossil ferns it appears to have more value. Abortive pinnæ at the base of the rachis, called *Aphlebia*, are commoner in fossil ferns, as *Schizopteris adnascens*, which is thus related to *Sphenopteris crenata*.

Section II. gives descriptions of the fructification of Carboniferous ferns. Genera with annulate sporangia are:—

Hymenophyllites, of which *H. quadridactylites*, Göpp., occurs in the Middle Coal-measures, Dudley. *Oligocarpia*, only British species, *O. Brongniarti*, Stur. Middle C. M., Barnsley. *Senftenbergia*, not known as British. *Corynepteris*, Irish and English. *Zygopteris*, several British species. *Schizostachys*, one species found in the Radstock Coal-field.

The exannulate genera are:—

Scolecopteris, only British species, *S. polymorpha*, Brongn., Upper C. M. *Asterotheca*, many British species, usually called *Pecopteris*. *Ptychocarpus*, ex *P. unitus*, Brongn., Upper Coals. *Calymmatotheca*, ex *C. affinis*, L. and H., *C. bifida*, L. and H., *C. asteroides*, Lesq., Middle C. M. and Calciferous Sandstone. *Crossotheca*, *C. schatzlarensis*, Stur., from the Middle C. M., Barnsley. *Renaultia*, ex *R. microcarpa*, Lesq., Lower C. M., Fife, and *R. gracilis*, Brongn., Newcastle. *Dactylotheca*, ex *D. dentata*, Brongn., Upper and Middle C. M. *Cyclotheca*, ex *C. biseriata*, Kidst., Lower C. M., Scotland. *Myriotheca*, not observed in Britain. *Sphyropteris*, ex *S. obliqua*, Marrat, Middle C. M., St. Helens; and *S. Boehnischi*, Stur., Lower C. M., Alloa. *Urnatopteris*, ex *U. tenella*, Brongn., Lower C. M., Alloa. *Archæopteris*, ex *A. hibernica*, Forbes, Ireland. *Unatheca* (gen. nov.), frond tripinnate ?, pinnæ sub-opposite, lanceolate, pinnules sub-opposite, oblong, usually bearing four pairs of oblong lobes and a terminal one. On each lobe is an oblong sporanguim, placed horizontally, which opens by a longitudinal

cleft. Type *U. oblongus*, Kidst., Upper C. M., Radstock [fig. 105].

Genera of uncertain affinities are:—

Zeilleria, ex *Z. delicatula*, Stur, Forest of Wyre. *Chorionopteris*, no British forms mentioned. *Neuropteris*. The only fruiting specimen is *N. heterophylla*, Brongn., Lower C. M., Fife. *Dicksoniites*, ex *D. Pluckenetii*, Brongn., Upper C. M., Radstock.

Section III., Fern Stems.—Three British types are known:—

Caulopteris.—With circular or oval smooth scars, arranged quincuncially, either with a "horse-shoe" inner ring, or an oval one with a transverse scar within. The British forms show the first kind, and are *C. primæva*, L. and H.; *C. anglica*, Kidst.; and *C. cyclostigma*, Lesq., all from the Upper C. M.

Megaphyton.—Frond-scars in two opposite vertical rows, the type is *M. frondosum*, Artis, Yorkshire.

Psaronius.—Stem mostly of aerial rootlets arising from central vascular bundles, *P. Renaultii*, Will., Lancashire.

The internal structure of fern petioles is not characteristic of genera, hence the different bundle-arrangements are provisionally classed together under the names *Rhachiopteris*, *Dictyoxylon*, *Kaloxylon*, described by Williamson, and *Myelopteris*, which is Marrattiaceous.

Figures and detailed descriptions are given in the paper of all the genera above referred to.

***374. Kidston, R.—On the Fossil Flora of the Staffordshire Coal-fields.**

Trans. Roy. Soc. Edinburgh, vol. xxxv., p. 63.

The divisions of the Coal-measures adopted are those of J. Ward [No. **164**, 1890]. The minuter subdivisions, as to names of coals and ironstones, are adopted from Mr. Homer (Trans. N. Staff. Inst. Min. and Mech. Eng., vol. i., 1879). The following are the species recorded:—1 = Upper Coal-measures; 2 = Middle Coal-measures; 3 = Lower Coal-measures; 4 = Millstone Grit; * figured.

Calamitina varians, 2, 3, 4.
— ——— approximata, 2.
Eucalamites ramosus, 2.
Stylocalamites Suckowii, 1—4.
——————— Cistii, 3.
Pinnularia columnaris, 1—3.
Calamocladus equisetiformis, 1—3.
Sphenophyllum cuneifolium, 2, 3.
Sphenopteris obtusiloba, 3.
——————— grandifrons, 2.
——————— latifolia, 2.
*——————— spinulosa, 2.
——————— spinosa, 3.
Eremopteris artemisiæfolia, 2.
Pecopteris caudata, 3.
Alethopteris aquilina, 1, 2.
——————— lonchitica, 1—4.
——————— decurrens, 2, 3.
*Rhacophyllum crispum, 3.
Lepidodendron ophiurus, 2.
——————— obovatum, 2—4.
——————— aculeatum, 2—4.
——————— serpentigerum, 2.
——————— rimosum, 3.
Lepidophyllum lanceolatum, 2, 3.
——— ——— triangulare, 2.
Lepidostrobus variabilis, 1, 2.
Sigillaria discophora, 2, 3.

Neuropteris heterophylla, 2, 3.
——— tenuifolia, 2.
——— rarinervis, 2.
——— ovata, 1.
——— plicata, 2.
——— Scheuchzeri, 2.
——— gigantea, 2, 3.
Dictyopteris Munsteri, 2.
——— obliqua, 2.
Mariopteris muricata, 2, 3, 4.
Pecopteris arborescens, 1.
——— Miltoni, 2.
Sigillaria Brardii, 1, 2.
——— tessellata, 2, 3.
——— elegans, 2.
——— scutellata, 2.
——— rugosa, 3.
——— ovata, 2.
——— alternans, 2.
——— camptotænia, 2.
Stigmaria ficoides, 1—4.
Cordaites borassifolius, 2, 3.
Artisia transversa, 2.
*Rhabdocarpus sulcatus, 1.

Three new forms of macrospores are also described, called Triletes xix., xx., xxi. [figs. 106—8], all from Middle Coal-measures; and some account is also given of the erect trees at Eastwood Marl Pit standing out of the 3-inch coal.

375. Solms-Laubach, H. Graf zu.—Fossil Botany, being an introduction to Palæophytology from the standpoint of the Botanist.

Oxford: Clarendon Press, large 8vo, pp. 401. Translated by **H. E. F. Garnsey,** with 49 illustrations.

This is "the only critical digest yet published of our present knowledge of Fossil Plants from the point of view of Botanical Morphology." It does not cover the whole ground, but is confined to the lower types. The groups of these are dealt with in the following order: I. Thallophytes, Bryinæ; II. Coniferæ; III. Cycadeæ, Medulloseæ; IV. Cordaitæ; V. Miscellaneous Gymnospermic types; VI. Ferns; VII. Equisetaceæ, &c.; VIII. Lycopodites, &c.; IX. Lepidodendreæ; X. Sigillarieæ; XI. Stigmaria; XII. Calamariæ; XIII. Sphenophylleæ; XIV. Doubtful remains, known by structure only; XV. Doubtful remains, known by surface only. The list of publications occupies 17 pages, and the whole is a storehouse of information on the facts and views acquired up to date.

***375a. Williamson, W. C.—General, Morphological and Histological Index to the Author's Collective Memoirs on the Fossil Plants of the Coal-Measures, Part I.**

Mem. and Proc. Manchester Lit. and Phil. Soc., vol. iv., p. 53.

Gives first a list of his writings, lettered A to Z, and then a list of the *Calamariæ*, whose structure some of them elucidate, stating what structures are described, in what memoirs, and on what pages, and by what figures illustrated; in the last case giving references to the originals in his cabinet.

The general structure of Calamites includes—I. Axial Tissues. The primary medulla, partial absorption of medulla and nodal medullary diaphragm; the xylem in

transverse sections, longitudinal sections, at internodes, at nodes; the compound tracheæ, exogenous growth, primary and secondary medullary rays, nodes, and internodes, internodal canals and rhizomes; the primitive cortex and its varieties; the branches, their nodal positions and development, and verticils; the roots with infranodal canals; and the leaves. II. Fructification, including the axis of the strobilus and its medulla, the medullary cavity, internodal canals, xylem bundles, peduncle and cortex; the peripheral appendages, as nodal disc, lacunæ of disc, marginal disc-rays, sporangiophores, sporangia, and spores; the inorganic casts of the medullary canal, and the relations to Calamodendron and Equisetum.

The species whose structure has been elucidated are—

Calamites verticillatus, L. & H.
Palæostachya pedunculata, W.
Paracalamostachys Williamsoniana, Weiss.
Asterophyllites sphenophylloides, W.
Asterophyllites insignis, W.
Calamostachys Binneyana, Sch.
———— Cashiana, W.
Pothocites Grantoni, Paterson.

376. Carruthers, W.—Demonstration on Fossil Vascular Cryptogams.

Proc. Geol. Assoc., vol. xii., pt. 3, p. 88.

All Palæozoic club-mosses whose fruits are known are heterosporous, and belong therefore to the *Selaginellaceæ*, and not to the *Lycopodiaceæ*, which latter family occurs first in the Upper Mesozoic.

377. Spencer, J.—The Common Fossil Plants of the Coal-Measures.

Trans. Leeds Geol. Assoc., part vi., p. 24.

General remarks on forms and their names, noticing the changes that have taken place in the naming of *Calamites*, *Lepidodendron* and *Sigillaria*.

378. Reid, C.—The Origin of the Flora of Greenland.

"Nature," vol. xliv., p. 299.

It is not pre-Glacial, for the uncovered mountain tops would be too high for the plants. It thus represents the stage of a country recovering from a Glacial period, and gaining a new flora, corresponding to the lacustrine beds overlying the Boulder Clay in England.

379. Bower, F. O.—Is the Eusporangiate or the Leptosporangiate the more Primitive Type in the Ferns?

"Annals of Botany," vol. v., p. 109, pl. vii.

"The opinion currently held by botanists is, that the simpler Leptosporangiate ferns are the more primitive, and that the Eusporangiate ferns occupy a higher position in the

developmental tree," and this opinion was formerly shared by the author. But he now opens the question again, and after discussing the supposed relations of the Leptosporangiate [or Filmy] ferns to the mosses, he takes up the palæophytological line of evidence. Almost all the older ferns are Eusporangiate; even in the *Palæopteris hibernica* it is only the sorus and not the actual sporangium that has led to its being considered Leptosporangiate. He then describes and figures some fern sporangia from the Coal-measures. In these "the superficial layer of cells has thickened and forms cell-walls, but the individual cells are of very irregular size and shape; no definite ring-like annulus can be traced." Within this layer some internal cells form a partial internal sheath, or there is in their place a simple line. The spores are numerous and isolated. These are probably the "annulate sporangia" of Mr. Kidston. They bear a remarkable resemblance to the sporangia in *Todæa barbara*, both in the irregularity of the thick outer layer and in the thin inner sheath. This seems to indicate their probable Osmundaceous character.

He then quotes the results of Stur (Abh. kk. Geol. Reichs. Wien, 1885), as follows:—

		Present Flora.	Carboniferous.
Ophioglossaceæ—	genera	3	2
	species	17	19
Marattiaceæ—	genera	4	15
	species	23	98
Polypodiaceæ?—	genera	108	4 or 5
	species	2,700	58

On this he notes the relative abundance in Carboniferous times of Marattiaceæ, and considers "the present Eusporangiate Ferns to be the reduced remnants of a more prevalent race of former times, while the Leptosporangiate were, in the main, a race of later origin."

379a. Barber, C. A.—The Structure of Pachytheca. II.

"Annals of Botany," vol. v., p. 145, pl. ix.

In a previous paper (A. B., vol. iii.) the author showed that these spherical bodies, which occur in various beds from the Silurian to the Old Red Sandstone, consisted of (1) a medullary portion of filaments passing in all directions; (2) a cortical portion in which the cell-rows were disposed radially; and (3) a zone of dubious nature uniting the two called the zone of oval bodies. He now describes 13 slides which have been obtained by J. Storrie from the Tymawr Quarry, Cardiff. These now demonstrate that (1) *Pachytheca* is a spherical alga, having the *medullary* portion, with the cell-rows passing in every direction, and a *cortical* portion continuous with it, in which the cell-rows are radial. The cortex may be divided into three zones, the inner with cell-

rows widely separate, the middle with unbranched, and the outer with branching filaments. 2. The zone of oval bodies are spaces between the concretions around, and encrusting, the cell-filaments. 3. Much of the cellular structure, network of tubes, &c., are concretionary deposits around the original living cellular framework. 4. This cellular framework has for the most part entirely disappeared. 5. The transverse walls do not completely bridge the spaces between the longitudinal walls.

On p. 223 is a note on this paper by **W. T. Thiselton-Dyer** for the purpose of pointing out that he had recorded the continuity of the cortical and medullary tissue in one of Sir J. Hooker's sections, but that his observation had never been confirmed till now, by the independent and more precise evidence adduced in this paper.

MINERALOGY.

METHODS.

380. Trouton, F. T.—A Co-efficient of Abrasion as an Absolute Measure of Hardness.

Rep. Brit. Assoc. for 1890, p. 757.

Moh's scale is arbitrary, and it is proposed to determine hardness by the amount abraded off a given surface (a) when rubbed on another surface of the same mineral at a given velocity (v), for a given time (t), under a given pressure (p)—the loss $M = \frac{v\,p\,a\,t}{k}$ where k is the co-efficient of hardness required.[1]

381. Joly, J.—On the Determination of the Melting Points of Minerals.

Proc. Roy. Irish Ac., 3rd series, vol. ii., p. 38.

The method adopted is as follows: Two upright forceps, one electrically insulated, are attached to a disc-shaped brass plate, clamped to a microscope stage. These forceps hold between them a platinum ribbon, about 1·2 mm. wide, narrowed at the ends where held by the forceps, and about 2 cm. long. This is put into a voltaic circuit with two Grove cells, and the current regulated by a special resistance. This resistance consists of two rods of carbon, such as is used for electric light, each 51 cm. long and 17 mm. in diam., and each having a resistance of about half an ohm; these rods

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[1] This method appears to be intended for amorphous minerals in bulk.

are clamped at their ends to a board, and there is a sliding piece, composed of two sprung brass tubes, one encircling each carbon, and connected by a cross-piece of brass, which can be slid along the carbons. The resistance to the current, which enters and leaves the same ends of the carbon rods and has to pass along one of them, then along the cross-piece, and back along the other, can thus be regulated. The apparatus is called the meldometer. For use, the mineral is finely powdered and moistened. and the platinum ribbon wetted with it. On passing more and more current the mineral may be made to fuse, and the melting point and other phenomena compared with those of already known minerals. The actual determination of the temperature of fusion in centigrade degrees is carried out by means of a modification of this apparatus, in conjunction with known results obtained by other methods. The examination of the material on the ribbon is made under the microscope with a single lens object glass and a neutral tint cover to the eye-piece.

Some special results are noted. Of the various felspars, sanidine melts at 1,140° C.; adularia, microcline, and albite at 1,175° C.; oligoclase at 1,220° C., and labradorite at 1,230° C., quartz above this. Most rock-forming minerals melt between 900° and 1,500°. Topaz blisters and forms coloured rings, iolite turns milk-white, as does any mineral with much lime, *e.g.*, labradorite. Orthoclase produces bubbles; tourmaline boils, and gives a whitish-yellow sublimate; beryl bleaches, and enstatite volatilises, giving a pale brown sublimate. In any case this method may be used instead of the blowpipe for beads, &c., and is more exact than van Kobell's scale of fusibility, which is not a regular scale, and orthoclase is given in the wrong order; the melting points being: Stibnite 525°, Natrolite 965°, Almandine 1,265°, Actinolite 1,296°, Orthoclase, 1,175°, Bronzite 1,300°, Quartz 1,430°.

***382. Sollas, W. J.—A Method of Determining Specific Gravity.**

"Nature," vol. xliii., p. 404.

An exposition of the method of the diffusion column [*see* No. **437**] produced by placing a heavy liquid in a glass tube and covering it with a lighter so as to make a column of gradually increasing density. Each level thus corresponds to a certain density, ascertained by the use of floats of known density.

383. Burghardt, C. A.—On a Rapid Method for the Accurate Recognition of Sulphides, Arsenides, Antimonides, and Double Compounds of these Bodies with Metals.

Miner. Mag., vol. ix., No. 43, p. 227.

This method consists in oxidising the sample by fusing it in a finely powdered state with nitrate of ammonia, either in a platinum crucible with a handle, or in a hard glass tube, closed at one end, and at the other end fitted with a cork and fine tube. Thus sulphates, arseniates, and antimoniates are produced, which are then tested in the usual wet way, or, in the cases of orpiment, realgar, and stibnite, by the gases produced. An unpublished reaction for bismuth is also mentioned. By adding caustic soda to the sulphate a white precipitate is formed; to this is added a stannous solution obtained by adding caustic soda in excess to stannous chloride, when a black precipitate of Bi_2O_2 is formed. It is noted also that when oxides of cobalt and nickel are formed together, on further fusion with ammonium nitrate in lumps the cobalt becomes soluble and the nickel is left behind.

383a. Hampe, W.—Analysis of Grey Copper Ore, &c.

"The Analyst," vol. xvi., p. 151. (Translated from the *Chemiker Zeitung*, No. 26, 1891.)

Recommends that the mineral be dissolved in a mixture of pure nitric and tartaric acids. The details are entirely chemical.

***384. Miers, H. A.—A Student's Goniometer.**

Miner. Mag., vol. ix., No. 43, p. 214, pls. iii.—v.

This consists of two concentric vertical discs, one fixed and one movable, with vernier scale on the fixed one, and the movable one graduated and clampable, the fine adjustment being worked by a transverse screw. The centre of the axis is made hollow, so that the simple Wollaston holder may be replaced, if desired, by the more complicated one of Von Lang. All this is supported on a vertical metal frame, standing on two levelling screws, the base of the instrument being a horizontal brass tube, supported by a third levelling screw. On this tube slides;—either a split ring with screw, supporting another transverse tube, with a cylinder sliding inside, the tube having a mirror attached to it by a capstan head screw, by which means the mirror may be placed in any desired position parallel to the axis;—or a vertical circular framework carrying a telescope and collimator. Made by Troughton and Simms, New Charlton.

385. Sang, E.—Investigation of the Action of Nicol's Polarising Eye-Piece.

Proc. Roy. Soc. Edinburgh, vol. xviii., p. 323.

This is a paper read in 1837 and now for the first time printed. It shows that the author proposed as a polariser the use of a plate of calcite between two glass prisms, which has in recent years been re-proposed by E. Bertrand.

386. Gorham, J.—A System for Constructing Crystal Forms by the Plaiting of their Zones.

Miner. Mag., vol. ix., No. 43, p. 235.

Long strips of cardboard are made, containing the faces of the several zones, and these are folded and plaited in, 1 over 2, then 3 over 1, and then 2 over 3, and so on.

THEORETICAL.

387. Williams, G. H.—Elements of Crystallography.

London: Macmillan & Co. Small 8vo, pp. 250, figs. 383.

This commences with the general principles of crystal structure and their representation, then goes through the various systems. Crystal aggregates and imperfections are then dealt with, and, in an appendix, zones and projections—the explanation of how to draw a linear projection by Weiss' notation being given. The subject cannot be said to be put in an attractive form.

***388. Blake, J. F.—Geological Optics.**

Proc. London Amateur Sc. Soc., vol. i., p. 66, pl. i.

Gives an elementary exposition of the reasons of the phenomena seen in examining minerals under the microscope. Recommends the use of the parabolic reflector. Explains the reason why more refractive minerals look brighter and appear to stand out from the surface; the nature of dispersion, absorption, and interference with the formation of Newton's scale of colours; also the reason for extinction; for the colours between crossed Nicols; the method of determining the positive or negative character of the mineral; the cause of the coloured rings in uniaxial and biaxial crystals; the dispersion of the optic axis; pleochroism; circular polarisation, and the rotatory power of quartz.

***389. Fletcher, L.—The Optical Indicatrix and the Transmission of Light in Crystals.**

Miner. Mag., vol. ix., No. 44, p. 278.

The form of the wave-surface in a biaxial crystal, which led to the remarkable discoveries of internal and external conical refraction, may be assumed to be incontrovertible. It was, however, arrived at on the assumption that the elasticity of the ether was different in different directions, and its compressibility zero. The same form, however, has been obtained on other and inconsistent assumptions. On rigorous calculation, it has been shown that the vibratory motion of the parts of an elastic medium gives rise to two kinds of waves, due respectively to distortional and condensational-rarefactional vibrations, and for the explanation of the phenomena of light

it is necessary so to assume the characters of the ether that the latter may be absent. If this absence is due to their having an infinite velocity, the ether must be incompressible, and then the vibrations must be in the plane of polarisation; but other phenomena require them to be perpendicular to it, and thus, on the assumption of incompressibility, we arrive at a deadlock. Sir W. Thomson (Lord Kelvin), however, has now shown that, if the ether be boundless, we may assume the velocity of the condensational vibrations to be zero, and the ether must then be compressible, and the elasticity equal in all directions, though the "effective density" may be different in different directions. If this solution of the difficulty be accepted, it involves the abandonment of all terms which assume a varying elasticity, *e.g.*, "axes of optic elasticity."

The author then starts, *ab initio*, to explain what are the properties of rays of light which have to be correlated, and shows how the wave-surface may be arrived at by a simple generalisation which he believes to be analogous to, if not identical with, that by which it was arrived at by Fresnel. It may, in fact, be obtained empirically without making any assumptions as to the compressibility and elasticity of the ether. He first shows that the properties of any ray starting from a point O may be represented by a single line RN not passing through O. For the direction of the ray may be taken as the line through O perpendicular to RN, the length of RN may be taken inversely proportional to the velocity, and the plane of polarisation as that to which RN is normal. Starting now with an ellipsoid, which he calls the "Optical Indicatrix" [corresponding to the old "Ellipsoid of Elasticity"], he gives the following construction for arriving at the ray- or wave-surface. At any point R on the ellipsoid draw a normal RN, from the centre O draw a perpendicular to RN, along NO, produced through O, take Or inversely proportional to RN. Then r is the corresponding point on the wave-surface. This is proved analytically by showing that the co-ordinates of r thus obtained satisfy the well-known equation to the wave-surface.[1]

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[1] For the proof given by the author, the following still more direct one may conveniently be substituted:—

Let $a^2 x^2 + b^2 y^2 + c^2 z^2 = 1$ be the equation to the original ellipsoid, Then RN, the intercept on the normal at $x_1 y_1 z_1$ as above = perpendicular from the origin on the tangent plane at R $(x_1 y_1 z_1)$

and $\therefore \dfrac{1}{RN^2} (= Or^2) = a^4 x_1^2 + b^4 y_1^2 + c^4 z_1^2 = r^2$ say.

If $\xi\ \eta\ \zeta$ be the co-ordinates of N, and $x\ y\ z$ those of r we have, since N is on the normal,

$$\frac{\xi - x_1}{a^2 x_1} = \frac{\eta - y_1}{b^2 y_1} = \frac{\zeta - z_1}{c^2 z_1} \quad \cdots \quad \cdots \quad (1)$$

He also shows geometrically that the trace of this surface on each principal plane is a circle and ellipse.

From the above equation it is seen that for every direction of ray there are two values of r, and hence two points R_1R_2 on the indicatrix corresponding to any given ray direction. These points he shows geometrically to be in the planes of symmetry of a tangent cylinder parallel to the ray. The two normals are therefore at right angles, and so also are the planes of polarisation of the rays.[1]

The lines of single ray velocity for which these normals are equal, usually called *the* (secondary) optic axes, he calls "Optic Biradials," and proves geometrically that the planes of polarisation of any ray bisect the angles between the planes containing it and each of these biradials; also analytically the well-known formula $\frac{1}{v_1^2} - \frac{1}{v_2^2} = \left(\frac{1}{a^2} - \frac{1}{c^2}\right) \sin \sigma_1 \sin \sigma_2$ [which gives the shapes of the rings in biaxial crystals].

Since Nr passes through O.

$$\frac{\xi}{x} = \frac{\eta}{y} = \frac{\zeta}{z} \quad \ldots \quad \ldots \quad \ldots \qquad (2)$$

and since Or and RN are perpendicular

$$a^2 x x_1 + b^2 y y_1 + c^2 z z_1 = 0 \qquad (3)$$

From (1) $\frac{\xi - x^1}{a^2 x_1} = \frac{a^2 x_1 \xi + b^2 y_1 \eta + c^2 z_1 \zeta - 1}{r^2}$, since $x_1\, y_1\, z_1$ is on the ellipsoid

$$= \frac{-1}{r^2} \text{ from (2) and (3)}$$

$$\therefore \frac{\xi}{x_1} = \frac{r^2 - a^2}{r^2}, \text{ \&c.}$$

Substituting successively in (2) and (3) we get

$\frac{a^2 x^2}{r^2\, a^2} + \frac{b^2 y^2}{r^2 - b^2} + \frac{c^2 z^2}{r^2 - c^2} = 0$, which is the ordinary equation to the wave-surface.

[1] In the proof of these and other propositions the values $r_1\, r_2$ obtained from the equation to the wave-surface are introduced, but except when the velocity of the ray is being dealt with, it is plain that the properties proved are simply properties of an ellipsoid. Thus the first of the above propositions may be stated as follows :—

"Two normals to an ellipsoid which meet the same radius at right angles, are themselves at right angles."

For if, as before, $\xi_1\eta_1\zeta_1$, $x_1y_1z_1$ and $\xi_2\eta_2\zeta_2$, $x_2y_2z_2$ be the co-ordinates of N_1, R_1, N_2, R_2

$$\xi_1 - x_1 = a^2 x_1 \lambda_1, \text{ \&c.}$$

$$\therefore a^2x_2\xi_1 + b^2y_2\eta_1 + c^2z_2\zeta_1 - (a^2x_1x_2 + b^2y_1y_2 + c^2z_1z_2)$$
$$= (a^4x_1x_2 + b^4y_1y_2 + c^4z_1z_2)\lambda_1$$

but since $\frac{\xi_1}{\xi_2} = \frac{\eta_1}{\eta_2} = \frac{\zeta_1}{\zeta_2}$, and the normal at $x_2y_2z_2$ is perpendicular to the radius to $\xi_2\eta_2\zeta_2$, the first three terms on the left-hand side together $= 0$.

Similarly, $-(a^2x_1x_2 + b^2y_1y_2 + c^2z_1z_2) = (a^4x_1x_2 + b^4y_1y_2 + c^4z_1z_2)\lambda_2$

$\therefore$ by subtraction, $a^4x_1x_2 + b^4y_1y_2 + c^4z_1z_2 = 0$, which proves that the normals at R_1R_2 are at right angles.

The remainder of this section deals with "front normals" and the corresponding "Optic Binormals," and leads on to "biradial" and "binormal cones," *i.e.*, to the expectation of internal and external conical refraction. Thus the whole phenomena are deducible from one empirical assumption.

The author then starts a new section, in which he builds the undulatory theory with as few assumptions as possible up to the point of explaining ordinary light as a succession of variously orientated elliptically polarised rays. He then points out that as the *period* of a wave $\left(\frac{\lambda}{v}\right)$ must remain constant for the same colour, it is only when the velocity (v) is constant that the colour can depend simply on the wave *length* (λ), and this is not the case in a doubly-refracting medium.[1] He calls the influence of the medium on the velocity of a ray in a given direction the "velocity factor," which is part of the general influence, due possibly to differences of effective density, which he calls "optical resilience." He then shows, conversely to his former method, how the wave-surface may be deduced from considerations of symmetry. In orthorhombic crystals the trace on OYZ of the ray-surface must be a circle and an independent ellipse, *i.e.*, its equation when $x = 0$ is

$$(y^2 + z^2 - a^2)(b^2y^2 + c^2z^2 - b^2c^2) = 0,$$

and similarly for the other planes of symmetry. On multiplying out this equation and filling in the symmetrical terms which disappeared when x was made $= 0$, we obtain the equation to the ray-surface. As the optical properties are not found to be different in relation to the rectangular axes, when the physical symmetry of the crystal is less complete, the same form of wave-surface will hold for the oblique systems. Considering the general direction of the ray, he then justifies his original empirical assumption as to the normal representing the ray. In this method no assumption is made as to the compressibility of the ether, but the component of the resilient force which is normal to the vibration is regarded as balanced by an equal component of the initiatory force.

***390. Judd, J. W.—The Rejuvenescence of Crystals.**

"Nature," vol. xliv., p. 83. (Lecture at the Royal Institution.)

The following properties of crystals are laid down:—

"Crystals possess the power of resuming their growth after interruption; and there appears to be no limit to the time after which this resumption of growth may take place." Zoned crystals are instanced, particularly those in which the outer zones are of isomorphic compounds in cubical crystals,

[1] **Does this account in part for pleochroism?**

or plesiomorphic compounds in others. If the crystalline form of two minerals is similar, one may form zones round the other, though the chemical composition is quite distinct.

"If a crystal be broken, or mutilated in any way whatever, it possesses the power of repairing its injuries during subsequent growth." The fragmentary quartz, mica, hornblende, &c., amongst rock-forming minerals, which show secondary growth, are instanced.

"Two crystals of totally different substances may be developed within the space bounded by certain planes, becoming almost inextricably intergrown, though each retains its distinct individuality." Graphic granite and micropegmatite are instanced.

A crystal may undergo the most profound internal changes, "and these may lead to great modifications of the optical and other physical properties of the mineral; yet, so long as a small—often a very small—proportion of its molecules remains intact, the crystal may retain, not only its outward form, but its capacity for growing and repairing injuries." Minerals which are schillerised, and ultimately become partial pseudomorphs, are instanced, for they are surrounded by fresh, unaltered growths of the original substance.

All this is illustrated by a mass of Mull granite, in the druses of which fresh intergrown quartz and felspar has formed, though the walls are of altered and kaolinised material.

***391. Liveing, G. D.—Crystallisation.**

"Nature," vol. xliv., p. 156. (Lecture at the Royal Institution.)

The different forms of crystals "depend on the dimensions of the ellipsoids and the orientation of their axes." This ellipsoid is defined as follows:—"Each molecule has its parts in extremely rapid vibration, so that it occupies a larger space than it would occupy if its parts were at rest, and the excursions of the parts about the centre of mass are . . . comprised within a certain ellipsoid." The molecules have to be packed as tight as possible, and this gives the regular internal structure. The external forms are dependent on surface-tension, and they are bounded by plane faces because on such faces the concentration of the molecules is the greatest, and therefore the surface-tension least. These results are applied to the explanation of J. W. Judd's statements above [No. **390**]. However long a crystal may stop growing the surface-tension remains the same, hence, when replaced in suitable material, it will re-grow. The broken parts will have greater surface-tension, and therefore will so grow as to replace this tension by a smaller, *i.e.*, to make a crystal face. The formation of hemihedral crystals is, doubt-

less, due to their formation under stress, electrical or otherwise. This is shown by some being pyroelectric, and others rotating the plane of polarisation, when unsymmetrical, but not when symmetrical. It is also shown by the fact that rock salt has no action on polarised light in the ordinary state, but has such power when compressed, and in the same way a uniaxial crystal may be compressed so to behave like a biaxial one.[1]

***392. Liveing, G. D.—On Solution and Crystallisation.**

Trans. Camb. Phil. Soc., vol. xv., pt. i., p. 119.

A continuation of former papers, in which it is shown that if the ellipsoids above mentioned become spheroids, the crystal will in general be hexagonal, while for certain dimensions and orientations of the ellipsoids the crystals will have rhombohedral symmetry and cleavage. The faces of least surface energy are calculated for most of the known hexagonal and rhombohedral crystals and found to agree with the observed forms. The rotatory power of quartz is taken to be a dynamic effect connected with the internal strains indicated by its asymmetric hemihedry.

MINERALS.

***393. Miers, H. A.—The Tetartohedrism of Ullmannite.**

Miner. Mag., vol. ix., No. 43, p. 211.

Cubic minerals have not yet been proved to show tetartohedrism, though Ullmannite has been suspected of it, because from one locality it is tetrahedral and from another pyritohedral. A specimen of the latter in the British Museum, from Sarrabus in Sardinia, is a compound cube "whose faces are broken up into a number of distinct fields [of which four are shown], upon some of which the striæ are parallel to one diagonal alone, while upon the remainder they are parallel to the other." "It follows that the crystals are not only tetartohedral and twinned about the dodecahedral axes, but that they consist of enantiomorphous individuals."

394. Solly, R. H.—Cassiterite, "Sparable Tin," from Cornwall.

"Mineralogical Magazine," vol. ix., No. 43, p. 199.

The particular variety thus named resembles the "sparable nail of the cobbler." The author gives a list of all the "forms" observed (35), and a figure showing nearly all those which are characteristically developed. This variety differs

[1] This is probably also the explanation of birefringent garnets.

also from other varieties of cassiterite in being nearly always simple; if twinned the axis is normal to {101}. Some crystals cleave readily parallel to 110. He gives a table of the angles between the several forms, and concludes by a description of the known specimens, of which one from Carn Brea mine is a new occurrence.

***395. Trechmann, C. O.—Twins of Marcasite in Regular Disposition upon Cubes of Pyrites.**

Miner. Mag., vol ix., No. 43, p. 209.

This draws attention to a specimen from Bredlar in Westphalia. The cubes of pyrites are deeply striated, and on each face of the cube there is a twin of marcasite, showing the forms (m) 110, (l) 101, (r) 104, the twin plane and composition face being m, and in each case perpendicular to the cube face and parallel to its striations, the outer faces of m being parallel to the adjoining cube faces which are striated in the same direction.

***396. Heddle, M. F.—On the Optic Properties of Gyrolite.**

Miner. Mag. vol. ix., No. 44, p. 391.

The pearly-lustred plates of gyrolite, of which orbicular masses in the Treshinish islands are made up, show an apparently uniaxial, but really biaxial figure, the axial divergence being only 2°—3°. On the outer side of each loop is a brilliant pale blue field. The birefringence is negative.

397. Hardcastle, C. D.—Agates.

Trans. Leeds Geol. Assoc., part vi., p. 43.

Gives an account of the nature, source, mode of formation, and processes of preparation of agates.

398. Lobley, J. L.—On the Origin of Gold.

Rep. Brit. Assoc. for 1890, p. 824.

The author thinks that gold has been "derived from aqueous deposition" and "may" occur in beds of all ages. He thinks it cannot have been "originally derived from Plutonic sources," but does not indicate where else it could have come from, and suggests that silica "may" combine with gold, and be subsequently "segregated." Until this happened it would be at the bottom of the sea "aggregated by nuclei of metallic sulphides."

***399. Cole, Grenville A. J.—On Occurrences of Riebeckite in Britain.**

Miner. Mag., vol. ix., No. 43, p. 222.

The author has examined the rock in the heart of Mynydd Mawr, and finds the riebeckite never well crystallised; it partly occurs in "glomeroporphyritic" groups, and partly was formed ophitically at a later stage, probably owing to its easy fusibility. He does not, therefore, regard it as of secondary origin, as supposed by T. G. Bonney. Drift

pebbles of a riebeckite-bearing rock have been found by P. F. Kendall in the Isle of Man, and on Moel Tryfaen, agreeing better with one another than with that of Mynydd Mawr.[1] The crystals are of fair size, and occur ophitically amongst felspar, and also in the groundmass. The angle between *c* and *a* he has measured as 6° 0′, 8° 5′, 9° 45′, 8° 0′, thus inclining to normal amphibole.

***400. Fox, Howard.—On the Occurrence of an Aluminous Serpentine (Pseudophyte), with Flint-like Appearance, near Kynance Cove.**

Miner. Mag., vol. ix., No. 44, p. 275.

Blocks of white-looking rock are conspicuous in Kynance East Cliff. They are found to represent parts of a vein which traverses the serpentine, and has suffered disturbance. These masses consist of a harder white substance like felspar, and a softer, flint-like, sometimes translucent, material of darker colour. This flint-like substance, on analysis by **Mr. Player,** yields SiO_2 33·3, Al_2O_3 21·8, Fe_2O_3 ·4, MgO 29·7, H_2O 14·9 = 100·1; sp. gr. 2·57—2·54. It thus agrees closely with pseudophyte from other localities, but has a little less silica, iron and magnesia, and more alumina.

***401. H[arker], A.—Minerals in Cumberland and Westmoreland.**

"The Naturalist" for 1891, p. 15.

To the list of minerals from Cumberland and Westmoreland, previously given by J. G. Goodchild, the following are added: essonite, grossularite, vivianite, sphene, agate, and andalusite.

***402. Irving, A.—Note on the Occurrence of Melanterite in the Upper Eocene Strata of the Thames Basin.**

Miner. Mag., vol. ix., No. 44, p. 392.

A bed of bright green sand was met with in a well near Wellington College Station, sunk in the uppermost bed of Middle Bagshot. This turned brown on drying without heat. A portion still green was digested in distilled water. The residue weighed 1·695 gm., and the filtrate yielded the equivalent of 0·19 gm. of hydrated sulphate of iron. Hence 12·4 per cent. of melanterite is present in the portion analysed.

***403. Heddle, M. F.—On the Occurrence of Sapphire in Scotland.**

Miner. Mag., vol. ix., No. 44, p. 389.

In a specimen of red andalusite in quartzose veins in the schist of Clasharee Hill, Clova, Aberdeenshire, is seen a blue hexagonal crystal $\frac{1}{80}$-in. in diameter. It is highly refractive,

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[1] This is a remarkable confirmation of the idea that the Drifts of Moel Tryfaen have been brought from the North out of the sea.

has a deep blue centre, and six dark blue rays. It is negative, and shows uniaxial rings. Hence it is a sapphire. Though its hardness is called 9, that of andalusite 7½, and that of xenolite, which forms a sheath round it, 6, yet on polishing it became brilliant, while the andalusite was quite rough and the xenolite dug out as a trench. Hence the scale of hardness is not approximately relative. He recommends testing for hardness by the amount of orthoclase or quartz worn away by equal bulks of the powder. [Compare No. **380.**]

***404. Heddle, M. F.—On New Localities for Zeolites.**

Trans. Geol. Soc. Glasgow, vol. ix., pt. i., p. 72.

The localities given for red heulandite and stilbite are bogus ones, having been given by interested dealers, and none are at present known, but now **R. Kidston** has found three localities near Stirling, viz., on a spur of Black Craig, near the head-waters of Leckie Burn, in a reservoir embankment in the Touch Hills, and at Earlsburn reservoir in Touchadam Moor. Figures of red heulandite, *s t b m x*, from the second and third localities, show their various habit. A *simple crystal a b p* of harmotome, unstriated on *b*, also occurs, as well as some colourless pyramidal crystals of small size, whose re-entering angles at each of the edges he cannot explain.

***405. O'Reilly, J. P.—On the Occurrence of Idocrase in the County Monaghan.**

Proc. Roy. Irish Acad., vol. i., p. 446.

In an iron and manganese deposit in the townland of Calliagh is a vein of quartz penetrated by a honey-coloured lamellar mineral of sp. grav. 3·34, and hardness 5, which on analysis by **L. T. Spencer** gave

Silica	40·06
Alumina	16·03
Lime	37·46
Ferric oxide	4·23
Manganous oxide	1·16
Cupric oxide	0·21
Soda	1·00
Loss on ignition	2·07
	102·22

This is included within the range of the analyses of idocrase, and its colour indicates the variety *Xanthite*. The mineral is found in a quarry in Cambrian slate. The iron and manganese is in a lode 3 in. thick which contains 42·20 per cent. of ferric oxide, and 6·24 per cent. of manganese peroxide.

***406. O'Reilly, J. P.—On the Occurrence of Serpentine at Bray Head.**

Proc. Roy. Irish Acad., 3rd series, vol. i., p. 503, pt. xxi.

This is the "Trap Rock" discovered by Harkness, and described by Westropp as interstratified, but splitting up into smaller beds, and therefore considered intrusive, though, in parts, looking like an ash. In the Windgate Quarries about 7 or 8 ft. are seen. The sp. grav. is 2·80, hardness about 3½. It is of a green speckled colour. An analysis by Miss **M. W. Robertson** gives:—

SiO_2	39·863
CuO	0·180
FeO	17·312
Al_2O_3	10·070
Cr_2O_3	1·299
NiO	0·112
CaO	6·380
MgO	11·838
N_2O	1·289
CO_2	4·198
Loss on ignition	8·413
	100·954

This is compared with an unusual serpentine from Dillenburg, with which there is a certain amount of agreement.[1]

PETROLOGY.

GENERALITIES.

407. Hatch, F. H.—An Introduction to the Study of Petrology: The Igneous Rocks (Reviewed in Geol. Mag., Dec. 3, vol. viii., p. 276).

London: Swan Sonnenschein & Co., 8vo, pp. 128, with 43 illustrations.

This book is intended "not only as an introduction to the subject, but also as a handy work of reference." The first of these purposes it will scarcely serve, as it assumes too much knowledge, thus on p. 19 we come across "pinacoidal cleavage"; on p. 22, "paramorphic change"; on p. 28, "extinction," &c., all without any explanation. The second purpose it well fulfils, as the various recognised characters of rocks and their component minerals are given in brief, and as the author is "up-to-date," the latest names are introduced. The nomenclature may, in fact, be looked upon as an enlargement of his glossary at the end of Teall's Petrography. If a work could

[1] This is the only reason assigned why it is called a serpentine. Yet its analysis is not like that of an *ordinary* serpentine; no thin section has been examined, and thus no proof is given that the material is homogeneous.

be written which served the first purpose (see, indeed, No. **60**) it would be as the living body to this skeleton.

The book begins with the mode of occurrence of the igneous rocks, pp. 9—14, in which "intrusive" rocks are said to form "the connecting link between plutonic and volcanic." The constituent minerals of igneous rocks occupy pp. 15—65. They are divided into original and secondary, and the former into essential (defined as one whose presence is implied in the name of the rock) and accessory. The essential are quartz, felspars, nepheline and leucite, muscovite, biotite, amphiboles, pyroxenes and olivine. The structure, chemical composition and alteration of the igneous rocks, with the explanation of the names applied, occupy pp. 66—76. The classification, and description of the igneous rocks, occupy pp. 77—125. The "elastic" classification is into groups and families as follows: Acid Group = Granite, Elvan and Rhyolitic Families; Intermediate Group = Syenite and Diorite, Micatrap and Lamprophyre, Trachyte and Andesite Families; Basic Group = Gabbro, Dolerite and Basalt Families; Appendix to Basic Group = Pyroxenite and Hornblendite, Magma Basalt Families; and Ultrabasic Group = Peridotite and Serpentine Families.

The following details may be noted. P. 14, allogenic should be allothigenic; on p. 41 the rock of Mynydd Mawr is called a "felsite," on p. 84 a "granophyre"; on p. 43 bastite is said to be a "fibrous substance"; on p. 63 hornblende is said to give rise to "bladed"—augite to "netted" serpentine, but on p. 124 both these forms are said to arise from augite and "lattice" structure from hornblende—the latter statement is explained and is apparently the one intended to be taken; on p. 67 the name "phenocryst" is mentioned for "porphyritic constituent"—but not the English word "inset." In connection with spherulites, "lithophyses," or hollow spherulites, are not mentioned. On p. 87 "eurite" is referred to as a "white microgranite," and on p. 91 as a "felsite"—and placed thus in two different families; on p. 101 phonolite is said to occur only in the Wolf Rock, though it is now believed to be the rock of North Berwick Law and the Bass; on p. 118 we read "The 'Pebidian formation' . . . consists of basic lava"!

***408. Chapman, F.—On the Preparation of Rocks and Fossils for the Microscope.**

Proc. London Amateur Sc. Soc., vol. i., p. 50.

Mentions the method of slicing vesicular specimens by first soaking in hardened balsam, and the method of turning over minute objects in order to grind the other side by first attaching them to a plate of mica, which can afterwards be reversed on to the slide.

409. Evans, J. W.—**An Inexpensive Apparatus for the Isolation of Minerals by means of Heavy Liquids.**

Geol. Mag., n.s., Dec. 3, vol. viii., p. 67.

The object to be attained by such an apparatus is—1. To completely separate the minerals which are heavier than the liquid, from those that are as heavy or lighter; 2. To extract the material that has sunk to the bottom. To these ends the liquid and minerals are placed in a funnel-shaped tube, which is continued cylindrically at the top, and is closed with india-rubber tube and stop-cock at the bottom. Into this fits a cork, through which one tube, perforated at the end, passes into the liquid, and another by which the air can escape, so that the contents may be stirred by air. To extract the material from the bottom another cork is fixed in the cylindrical part, and is perforated by a thistle tube, with a piece of stretched india-rubber tube over the lower end, by which means, when inserted into the neck of the funnel, it acts like a cork, and when the stop-cock is opened only the liquid below this runs out with the heavy minerals. This part may also be stirred by a thinner glass rod passed down inside the thistle tube, which, at the same time, serves as a cork to the end of the tube while this is being pushed down into the liquid. When methylene iodide is used the india-rubber must be replaced by ground glass adjustments.

410. Edwards, W. B. D.—**On the Preparation of a Cheap Heavy Liquid for the Separation of Minerals.**

Geol. Mag., Dec. 3, vol. viii., p. 273.

The method is as follows:—Dissolve 450 grains of sodium tungstate in as little boiling water as possible, add slowly 675 grains of boric acid in small crystals. Allow sodium borates to crystallise out by repeated stages and partial evaporations till the sodium borotungstate is obtained as a heavy liquid in which felspar floats. Boil this, and add 150 grains of $BaCl_2$ dissolved in 200 cc. of water, a little at a time. Wash and collect the precipitate, and add 300 cc. of 10 per cent. HCl. Evaporate to dryness, adding 40 cc. of HCl. towards the end. Dissolve in 300 cc. of hot water, and filter off the green tungstic hydrate. Evaporate down till most of the barium borotungstate is obtained as light-yellow lustrous crystals. Recrystallise and dissolve in 200 cc. of water, and add $CdSO_4$ drop by drop. Filter and evaporate to sp. gr. 3·46. On standing, some crystals separate, and the sp. gr. falls to 3·28.

***411. Rutley, F.**—**Notes on Crystallites.**

Miner. Mag., vol. ix., No. 44, p. 261.

The stages of the formation of crystallites in a glass are classified as follows. New names are in italics:—

PRIMITIVE STAGE.

Globulite.

Margarite. *Clavalite.* Longulite. *Spiculite* (Belonite).

Bacillite.

SPHERULITIC STAGE.

Cumulite.

Spherulite. Globosphærite.

Axiolite.

Scopulitic Spherulite. Trichite.

SETULATE STAGE.

Scopulite.

CHIASMOLITIC STAGE.

Arculite. *Furculite.*

½ *Arculite.* *Biconcave Rotulite.*

¼ *Arculite.* *Crenulite.*

The *Clavalite* [fig. 81] is a club-ended longulite. The *Spiculite* [fig. 82] is pointed. The *Bacillite* [fig. 83] is a collection of longulites massed side by side. The *Scopulitic Spherulite* [fig. 90] is one which is equatorially constricted, and the fibres form sheaves at the two ends. The *Scopulite* [fig. 84] is rod-like in the centre and brush-like at the two ends. The *Arculite* [fig. 85] has four main ribs (only two being seen in a section) like bows set back to back, each has comb-like outgrowths parallel to the other bow. These may reduce to two bows (½ *Arculite*) or one bow (¼ *Arculite*) [fig. 86]. The *Furculite* [fig. 87] has a straight stem and forks at the two ends, with similar comb-like outgrowths. *Crenulites* [fig. 89] extend farthest at the exterior angles, and are swallow-tailed and stepped or crenulated between these at the two ends. *Biconcave Rotulites* [fig. 88] are biconcave, circular discs, which may interpenetrate each other at various angles, the interior structure being like a furculite or arculite.

IGNEOUS ROCKS.

*412. Geikie, Sir A.—History of Vulcanism in Britain.

Presidential Address, Proc. Geol. Soc., p. 63.

I. He would restrict the term Archæan to the most ancient gneisses, though there is no reason why rocks indistinguishable from them may not be found in younger formations. Except perhaps near Gairloch, "no portion of the fundamental gneiss has anywhere yielded a trace of materials . . . of sedimentary origin." Its parallel structures in some cases represent

traces of movement in the unconsolidated igneous mass. They are, however, deep-seated, and no indication of superficial accompaniments has been detected. These rocks were crossed, before being crumpled, by a series of dykes trending generally E.N.E. The oldest group are of plagioclase-augite, and resemble modern basalts, the next are peridotites and picrites, and the third granites. The only sign of corresponding surface rocks is in pebbles in the Torridon Sandstone.

II. *The Younger Schists—Dalradian.*—In the Highlands of Perthshire these are often so horizontal as to seem to be in their original order. This is in descending order: 17. Dark schist, calcareous schist, and limestone (Blair Athol). 16. Quartzite (Ben-y-Glo, Schiehallion). 15. Graphite-schist. 14. Calcareous sericite schist. 13. Sericite schist with bands of quartzite (Canlochan, Glen Isla). 12. Garnetiferous mica schists, and schistose pebbly grits. 11. Limestone (Loch Tay). 10. Garnetiferous mica schists and schistose grits. 9. Upper group of green schists. 8 like 12, 7 like 9. 6. Thick group of massive grits, often pebbly, with partings of mica schist and phyllite (Trossachs, Ben Ledi, Ben Voirlich). 5. Schists and shales, with occasional bands of pebbly grit (Loch Achray). 4. Band of very coarse conglomerate (between Lochs Achray and Ard). 3. Pale green, grey, and blue slates, with purple and red shales and bands of sandy flags (Aberfoil). 2. Pebbly rust-coloured greywacké and grit (Pass of Leny). 1. Black shales and flags with lenticular bands of limestone (Callander). These he proposes to call "Dalradian."[1] Amongst these, from 7 upwards, are numerous sills, now hornblendic. The "green schists" are a remarkable group, typically composed of granular quartz, with acicular hornblende, biotite, and chlorite along the foliation planes. The green part he considers to be fine basic volcanic dust once pyroxenic. Similarly, north of Pomeroy, in Tyrone, the Archæan gneiss is bordered by coarse agglomerates, tuffs, and lavas, passing up into chlorite schists. Their more than usual freshness is attributed to the protection of the gneiss.

[1] These, from their description, would appear to be a different series from the "newer gneisses," for which Dr. Callaway, some years ago, proposed the name "Caledonian," but their most characteristic portion—the green schists—are noted by the author (see further on) to be comparable with those of Anglesey, though he will not adopt the name Monian, on the ground that both the one name and the other covers, or may cover, rocks of different ages. It seems not improbable that the bulk of these "Dalradian" rocks may represent an expansion of the Lower Monian, for which the name may come to be equivalent.

In Anglesey there are certainly pre-Cambrian rocks. The foliated rocks S. of Llanerchymedd he considers Archæan, on account of their petrographical resemblance.[1] The rocks of the west and south are obviously sedimentary, but there is no proof that they contain no altered Cambrian. As a whole, their regional metamorphism shows them to be much older. "No one familiar with the Dalradian rocks of Scotland and Ireland can fail to be struck with the close resemblance which these younger Anglesey schists bear to them, down even into the minutest details." The upper part of the Holyhead quartzite, and the flaggy quartzites near the South Stack, are crowded with annelid pipes. The series contains bands of dark basic material, and these with the chloritic schists suggest volcanic activity.

III. *Uriconian.*—The Wrekin and Caradoc rocks are undoubted volcanic rocks, comprising lavas, pyroclastic rocks, and intrusive bosses. As proving the Cambrian quartzite to be unconformable, he does not consider the volcanic fragments in the latter to prove much, and he could find no evidence of unconformity in the north, but only in the south. If, however, as "is believed by Professor Lapworth," the volcanic rocks pass up into the Longmynd, there must be unconformity. Hence these may be pre-Cambrian, but he cannot see how the supposed Archæan masses on the west of the Longmynd could be brought there.

IV. *Cambrian.*—This he makes to include "all the known Palæozoic rocks which lie on each other conformably below the bottom of the Arenig group." That the Llyn Padarn felsite was in existence before the conglomerates containing its fragments is now indisputable, but there is no proof of unconformity. In petrographical character it finds its nearest analogies among the older intrusive quartz porphyries, and the presence of flow structure does not prove it superficial, as this occurs also in dykes. There is no scoriform portion, but this he thinks may have been worn off at the time. The rock is much cleaved, and the basic dykes may "quite easily be mistaken for included bands of green slate." The conglomerates lie on different horizons; their contents are very various, including Cambrian slates and volcanic rocks strange to the district. He then describes the felsite seen east of the conglomerate, its cleavage, and associated tuffs. There are grits higher up, and veins of felsite before the purple slate is reached.

He calls it an "error" for the Survey to have coloured

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[1] In the Address some importance appeared to be attached to the hummocky nature of the ground, which resembles that in N.W. Scotland, but this does not appear to be regarded as any proof of their age.

the similar rocks near Bangor "altered Cambrian."[1] A large proportion of the material was directly derived from volcanic explosions, the "halleflintas" being "exceedingly fine tuffs." The quartz felsites have never again appeared in Wales. He could not trace any unconformity between these rocks and the Silurian, and accepts the consequence that the Bangor beds represent the whole of the strata up to the Arenig rocks.

The Nuneaton infra-quartzite ashes he considers Cambrian, as also their probable equivalents in Charnwood Forest. On St. David's he reiterates his old views. He notes some breccias at the base of the series at Howth, and some green dust bands at Bray, both of which may be of volcanic origin.

V. *Silurian.*—The earliest volcanic eruption was at the close of the Lingula Flag period on Cader Idris, the indication being tuff bands often less than one inch thick, with black slate fragments. On the south side of Llyn Cau, towards the top of the series, is an agglomerate of felsitic lava. He notes, also, the broken crystals in the tuffs, and the bed of pisolitic iron ore in their midst. The central mass of "felspathic porphyry" is marked on the map as intrusive and contemporaneous, but the limits are not correct. Particularly a mass called "greenstone" below Llyn-y-Gadr on Cader Idris is a cellular trachyte. The similar rock on the summit is not intrusive, and on the south slope is an epidiorite in a spheroidal lava-like form. The highest lavas are true spherulitic felsites, with porphyritic plagioclase. One of the vents was on the site of Aran Mowddwy and another later one to the north. Below all this is a zone of sills of ophitic dolerites, which may be regarded as lateral emanations from the funnels towards the close of the volcanic period. There are also sills of eurite, but remarkably few dykes.

The Bala Volcanic series of Carnarvonshire is, as Mr. Harker states, "remarkable for the paucity of ashes, &c." They are acid felsites, with well-marked flow structure often indicating the *direction* of flow, as, *e.g.*, a basement felsite on Snowdon which comes from Mynydd Mawr. The bottom and top of the series is less acid, the summit of Snowdon consisting not of bedded ashes, as has been represented, but of a spherulitic felsite between two amygdaloids, from 100—150 ft. thick, over the ashes, and below fossiliferous shale, and there are many other lava flows amongst the tuffs of the mountain. In the lower part there is a huge felsitic agglomerate. "The most important volcanic vent in North Wales" is Y-foel-fras, on which are diabases, agglomerates, amygdaloids, and

[1] He does not, however, deny directly that they are "altered," or that they are "Cambrian."

felsite. The others are Mynydd Mawr, Clynnog Fawr, the Rivals, Penmaen Mawr, Carn Boduan, and Llanfoglen. A prominent knob of felsite agglomerate N.E. of Capel Curig may mark another neck. Into and below this volcanic series have been intruded a number of basic sills whose vents were separate and lay to the east; they are unaccompanied by dykes, hence "it is evident that the conditions for the production of sills must be, in some important respects, different from those required for dykes."

In Anglesey, he considers the agglomerates of Llangefni to be Lower Silurian, "the relation of these rocks to the Lower Silurian strata . . . could not be . . . determined, but he can see no reason for believing them to belong to a different system."[1] The conglomerates seven miles S.E. of Holyhead [Tygwyn?], with intercalated "tuffs," give evidence of volcanic action in Lower Silurian times. He regards the whole of the rocks of the northern district as of Bala age. He considers the bounding fault a theoretical one, without actual visible trace, and as assuredly non-existent. Where it reaches the shore at Carmels Point, the two groups of rocks seem to follow in unbroken sequence, and interstratified black shales occur higher up, while to the south, where a network of faults is indicated, the rocks form one great series, with abundant intercalations of volcanic detritus. Nearer Porth Wen, the suggestion that the bands of black shale have been faulted in is completely disproved by the coast section exhibiting many thin leaves of black shale. The age he considers to be indicated by *Orthis Bayleana*.[2] He then describes the necks along the northern coast, and alludes to the conglomerates, and to the possibly Upper Silurian age of the Parys Mountain felsite.

The volcanic rocks of the Lake District are more widely spread than seems the case at first, viz., northwards to Cockermouth and eastwards to Teesdale, over an area of 550 square miles, and are of an estimated thickness of 8,000—9,000 ft., which is the thickest accumulation in Great Britain. The lavas are andesites in the lower and central part, and one is almost a basalt, while the upper part is more acid, but none are very much metamorphosed. A much larger portion than is indicated on the maps consists of lavas, nevertheless, the pyroclastic material is very great in amount and variable in coarseness. The principal larger orifices were at Castle Head, two on Carrock Fell of distinct character, and two in the Vale of St. John, but the greater number were probably small, as one near Grange at the

[1] They have been previously considered to be pre-Cambrian.

[2] On these points see No. 65.

mouth of Borrowdale in Little Comb beck, where a boss of agglomerate is seen. He is not quite certain whether the eruptions were subaerial or not, and there are very few sills or dykes.

In the Southern Uplands of Scotland a number of supposed dykes are now found to belong to an underlying volcanic group exposed along denuded anticlinals. These run from St. Mary's Loch and Leadburn to the coast of Girvan and also along the southern borders of the Uplands. They are mostly porphyrites, but the S.E. portion is more acid. The mass lies between Arenig shales and Glenkiln shales and is thus of Llandeilo age. It is above them that the Radiolarian chert has been obtained.

In Ireland the best display of Lower Silurian Volcanic Rocks is in the south-east. The Rathdrum and Castletimon tract, Kilpatrick Hill and Arklow Head, are centres of eruption. Near Dunhill Bridge, co. Waterford, 50 ft. of rock show breccias corresponding to 10—12 explosions. Many of the so-called "Greenstone ashes" are crushed basic sills. The coast line of co. Waterford from Tramore to Ballyboyle Head presents "the most wonderful series of sections of volcanic vents within the British Isles"—agglomerates and felsites succeed each other in bewildering confusion. They pierce through Llandeilo-Bala shales on the east, and in Ballydouane Bay through red rocks which may be of Old Red Sandstone age.

The only Upper Silurian Volcanic relics are between Lough Mask and the sea, where there are porphyrites and amygdaloid, said to "lie in the higher part of the Upper Silurian deposits," and in the Dingle promontory where lavas, some of which are nodular with associated tuffs, lie amongst beds with Wenlock fossils, and a bed of huge felsitic agglomerate.

***413. Harker, A., and Marr, J. E.—The Shap Granite and the associated Igneous and Metamorphic Rocks.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 266, pls. x.—xii.

The intrusion of the Shap Granite is post-Silurian and pre-Carboniferous. The following is the series of rocks into which it, or its apophyses intrude, in descending order:—Bannisdale Slates; Coniston Grits; Coniston Flags, including the Upper, Middle and Lower Coldwell beds, and the Brathay Flags; Coniston Limestone, including Upper Limestone, Calcareous breccia, Rhyolite, and Stile End Limestone; and Upper part of Borrowdale series, including a Rhyolitic and an Andesitic group. Three sections are given and described showing the succession of these beds, their proportionate thicknesses, their characters and general changes as they

approach the granite. They are affected by certain described faults.

Three analyses are given, made by **J. B. Cohen,** on (1) the bulk; (2) the porphyritic felspars; (3) the ground mass of the granite:—

	(1)	(2)	(3)
$Si\,O_2$	68·55	65·41	68·89
$Al_2\,O_3$	16·21	18·97	15·48
$Fe_2\,O_3$	2·26		2.46
$Fe\,O$	?	0·51	tr.
$Mn\,O$	0·45	tr.	0·58
$Mg\,O$	1·04	0·01	1·04
$Ca\,O$	2·40	0·73	2·13
$Na_2\,O$	4·08	2·15	4·69
$K_2\,O$	4·14	11·23	3·70
	99·13	99·01	98·97

These show that the porphyritic felspars constitute $\frac{1}{10}$ of the mass. The minerals recognised besides quartz, biotite, and two felspars are: apatite, zircon, magnetite, and sphene, but no hornblende. The biotite is variously altered. The felspars are the earlier orthoclase, the plagioclase, and the later orthoclase. The first contains little patches of quartz, in one case a well-bounded crystal, and sometimes numerous round grains in the marginal portion. The quartz, was, therefore, partly of earlier consolidation. The ground mass contains a plagioclase as the dominant variety whose optical properties point to oligoclase, it is anterior to the quartz and the later orthoclase. The bubbles in the quartz which have been considered to indicate a depth of consolidation of 46,000 ft., may be accounted for by that mineral, which is of earlier formation here, being formed at a greater depth than the mass of the rock, which could not have been buried more than 14,000 ft., the maximum thickness of the Silurian strata.

The dark patches are more compact and more basic, the silica percentage being 56·95 instead 69·78, and they are heavier in the ratio of 2·769 to 2·687. There is more sphene and dark mica in them. The porphyritic orthoclase is corroded and surrounded by a border of plagioclase and quartz. In one block, in which there is banded structure and an apparent passage into a dark metamorphosed rock, though all is really granite, are numerous crystals of andalusite. Near the junction at Sherry Gill, a pegmatite band has its felspars largely replaced by quartz. Geodes and joints contain talc, chlorite, fluorite, malachite, iron pyrites, copper pyrites, molybdenite and mispickel ?.

At Stakeley Folds are several sills of micaceous quartz porphyries with quartz blebs. The oligoclase occurs in "clusters of small crystals with irregular junction with one

another, but presenting crystal forms to the surrounding ground mass." These are considered to have floated up from great depths.[1] Other sills are more like minette, but the whole group is a peculiar one. In two are found crystals whose centres are striated, probably oligoclase, surrounded by a narrow border of orthoclase, the two parts having Carlsbad twinning in common.

The largest dyke in the district has porphyritic felspars showing the usual characters of sanidine. Other dykes are briefly described, and a sketch map of them is given. The more micaceous ones resemble the dark patches in the granite, and are supposed to have come from a more widely spread, more basic magma below the granite, from which the dark patches also have floated up. The present boss of granite represents the channel through which the magma was forced, which was "punched out," and the magma finally consolidated in a "cedar-tree" laccolite.

The Metamorphism of the surrounding Rocks.—The andesite was made up of numerous thin flows, since it is vesicular throughout. It had been weathered before metamorphism, and the vesicles filled with delessite, quartz, or calcite. The felspar is andesine, and a little calcite and quartz veins occur. Epidote is occasionally found, but disappears near the granite. The thermo-metamorphism is first traceable at a distance of about 1,200 yards, but is well-marked at 800 yards. It commences in the vesicles, the delessite being changed into brown mica, or where more lime is present, as when crossed by a calcite crack, into green hornblende, and the quartz becomes more crystalline. The ground mass then develops brown mica which gives it a darker colour, and finally the vesicles lose their distinctness. Less common products are actinolite, augite, magnetite, pyrites, and sphene, and very rarely apatite. The original andesine is also changed into flakes of brown mica, &c., and all the minerals produced appear to be very stable and therefore fresh. In one example only has fresh felspar been formed in a vesicle, but along the old joints silvery mica is produced. The augite represents the old calcite veins. The specific gravity of the whole has increased from 2·736 to 2·8.

The metamorphism of the andesitic ashes is similar in character to the above, but there is more brown mica in proportion, and no sphene. The original lamination of the matrix, to whose direction the fragments often stand nearly vertical, is emphasised by lines of sericite, giving it a schist-like appearance, and this is increased in the altered rocks by the parallelism of the brown mica. A large part of the

[1] Might not these be pseudomorphs?

altered rock consists of reconstructed felspar. No complete chemical comparison has been made between the altered and unaltered rocks, but the former are found to contain only 50·75 and 50·90 per cent. of silica, which is 9 per cent. less than in the latter. This apparent loss of silica is not easily accounted for.

The rhyolites are never notably porphyritic, but consist of imperfectly individualised felspar and quartz. Some are nodular, others show laminated bands of microspherulites—a structure the authors consider to be primary. They were altered prior to the metamorphism by a process of silicification, the ground mass becoming a quartz mosaic of varying fineness. On approaching the granite this is reconstituted with fresh felspar and quartz, though perlitic cracks may still be indicated by micaceous films. Close to the junction the same result is clearer, but the silicified parts have not with certainty been recrystallised. The nodules show concentric bands of moderately coarse quartz-mosaic, and minutely crystalline aggregates of felspar and quartz, with parallel strings of mica flakes " which seem to answer to the well-known shells of the substance, which has " been " compared with pinite."

Analyses of I., the unmetamorphosed; II., the metamorphosed rhyolite by **E. J. Garwood** show:—

SiO_2	75·95	76·95
Al_2O_3	13·77	15·50
Fe_2O_3	3·48	2·00
CaO	0·25	1·05
Alkalies and loss	6·55	4·50
	100·00	100·00

The rhyolitic ashes include breccias and ashy grits. They generally show a wavy lamination, and are often silicified. At about 1,250 yards from the granite, spots $\frac{1}{80}$-in. in diameter occur. They are lighter than the mass which has been coloured by the formation of brown mica. Nearer the granite the spots become larger, $\frac{1}{10}$-in. At 250 yards every trace of original constitution is lost, the lamination being indicated by the lie of the mica flakes and the streaks of iron ores, which include ilmenite. A characteristic mineral is cyanite in little crystals, but the bulk of the rock is of fine-grained felspar crystals, with occasional rutiles. Nearer still, cyanite and light mica have disappeared—all have become dark mica—yet there is less in them than in the altered andesitic ashes. Near Wasdale Head Farm is a white micaceous rock. Those which have been previously silicified are metamorphosed less.

The Coniston Limestone series is not purely calcareous, but

the highest part is the purest. The metamorphism is first noticed 1,400 yards from the granite, and is complete at 300 yards. The Lower Limestone has produced an idocrase-garnet rock —the former mineral is ophitic, and of unusually bright polarisation tints. The garnets resemble grossularite, and "present in each crystal a division into several distinct fields, with different optical orientation." There is also "a zonary banding—concentric shells of the crystal differing in the amount of double refraction." A colourless augite also occurs in crystals and small globules ?, also tremolite, sphene, and anorthite. Another type shows a dull white ground mass of wollastonite, &c., with round light brown spots representing incipient garnet, here isotropic. The Upper Limestone is rendered porcellanous, with patches of brown lime-augite.

The calcareous breccia contains tremolite, suggesting a previous dolomitisation, also a lime-augite, wollastonite, and felspars, and the quartz of the original fragments has been recrystallised. An analysis of the changed Upper Limestone, by **E. J. Garwood** shows, SiO_2 55·45, Al_2O_3 15·91, Fe_2O_3 6·84, MgO 3·65, CaO 11·50, Na_2O 0·10, K_2O 3·36. The carbonic acid is all gone, and the amount of silica present is not more than would come from the ash.

In the Brathay Flags the carbonaceous matter has been burnt away and brown mica has been formed. Anatase, as pointed out by W. M. Hutchings, is developed at the expense of the "clay-slate needles." Nearer the granite are the spotted rocks, the spots being nearly devoid of mica and showing incipient crystallisation as a whole. The mica has a peculiar purplish-brown sheen. There is also white mica near veins of the same mineral. Scattered notices of the altered Coldwell Beds, including a fault breccia, follow. These include lime-augites when the beds were calcareous. The general distance to which metamorphism may be traced is independent of the nature of the rock, but the old minerals produced by weathering were first affected. No zones of metamorphism can here be laid down.

The map shows the relations of the granite and the associated rocks, and the plates give twelve microscopic sections of rocks described in the paper.

*414. Harker, Alf.—Petrological Notes on Rocks from the Cross Fell Inlier. (Appendix I. to a Paper by Messrs. Nicholson and Marr).

Quart. Journ. Geol. Soc., vol. xlvii., p. 512.

1. *The Skiddaw Slates* are locally gnarled. The chief secondary products are compared to delessite, clintonite, muscovite, and chlorite. The quartz grains are squeezed and superficially recrystallised. Crystals of pyrites have been formed and

moved, leaving vacant spaces now filled with quartz. Near the Cuns Fell diabase the slates have clear spots whence the dark matter has been expelled, and near the lamprophyre dyke of Dry Sike, have become a hornfels. In an andesitic lava of the period is seen a vesicle, first coated internally with delessite, then the coating has broken away into the interior, carrying part of the matrix with it, and from the latter are outgrowths of a plagioclase felspar. On Wythwaite Top is a dynamically metamorphosed ash, with fragments in a partly turbid, partly clear, matrix; the latter is of felspar. The porphyritically disposed turbid felspars have been broken and sometimes replaced by a new growth, like albite. There are also fine ashes and grits derived from various igneous rocks.

2. *Basic Lavas of Melmerby.*—These agree in general character and sp. gr. 2·753 with the Eycott Hill lava, and may be called hypersthene basalt. The ground mass contains a rhombic pyroxene replaced by bastite, also magnetite, plagioclase and augite.

3. *Rhyolitic Rocks.*—The normal form has small scattered plagioclase crystals in a glassy or microlitic ground mass. One at Keisley shows flow-brecciation. The "second rhyolite" below the Keisley limestone shows a number of spots $\frac{1}{100}$ in. in diameter, with fine felspathic microliths embedded in one crystalline mass of quartz. At Swindale Beck is an ash-like rhyolite with many caught-up darker fragments. It has crystalline streaks of felspar and quartz following the flow lines, and is therefore an "eutaxitic" lava.

4. *Acid Intrusive Rocks and Transitional Types.*—The "Dufton granite" is a quartz felspar porphyry with two micas and "microgranitic" ground mass. A variety in Ousby Dale has the felspars replaced by masses of white mica flakes, and similar flakes occur in the ground mass. This form "can be referred only to intense dynamic metamorphism." South of Cocklock Scar is a transitional mass to—

5. *The Lamprophyres.*—These have a dark grey ground with flakes of dark mica and occasional felspars, and in some, as at Swindale, rounded quartz. The micas are light in the interior, perhaps by secondary bleaching, as dark streaks cross the light. They are resorptive, show gliding planes oblique to the basal planes, and enclose hexagonally-placed rutiles, and minute zircon crystals with pleochroic halos.

6. *Basic Intrusive Rocks* consist chiefly of idiomorphic felspar and ophitic augite, the latter is seen changing to hornblende surrounded by a fringe of colourless hornblende, and then changing to delessite. The rocks vary in coarseness. At Deep Slack Wood is a finely crystalline dolerite, probably of much later age

7. *Quartzite of Roman Fell.*—This contains quartz with less felspar, both enlarged by secondary growth of the same mineral, thus becoming compact and vitreous-looking.

***415. Hutchings, W. M.—Petrological Notes on some Lake-District Rocks.**

Geol. Mag., Dec. 3, vol. viii., p. 536.

Detailed descriptions are given of a miscellaneous variety of igneous rocks found at various spots, viz., a quartz-andesite from near Dunmail Raise; a coarse-grained non-porphyritic dolerite above Easedale Tarn; a basalt from the summit of Scarp Gap Pass; altered augite andesites from Harter Fell, Nan Bield Pass, Kentmere Valley and Easedale Tarn; a fissile andesite between Seatoller and Seathwaite; basaltic andesite from Dale Head; and an andesitic basalt from Seatoller Fell. Parenthetically he objects to the terms porphyrite, melaphyre, propylite, &c., as not sufficiently defined. No hornblende-andesites have been found, and enstatite is rare. He describes also a vesicular andesite at Thornthwaite Crag, with clusters of felspars, idiomorphic on the outside of the group; of these he gives the following analysis by **J. B. Cohen**:—

Silica	58·69
Alumina	15·84
Ferric oxide	8·62
Lime	3·43
Magnesia	2·91
Manganous oxide	0·58
Potash	3·86
Soda	5·06
	98·99

This composition will do equally well for an andesite or trachyte. Finally he dwells on the difficulty of distinguishing a trachyte from a rhyolite, or either from an ash.

***416. Harker, A.—The Ancient Lavas of the English Lake District.**

"The Naturalist" for 1891, p. 145.

Gives "the leading characters of the main types."

***417. Tate, T.—On the so-called Ingleton Granite.**

Proc. Yorkshire Geol. and Polyt. Soc., vol. xi., pt. iii., p. 480, and Rep. Brit. Assoc. for 1890, p. 800.

This rock, recently introduced for road metal, is quarried in the Borrowdale series near Dale-beck. It extends across Dale above Ingleton, has a thickness of about 400 yards, with a sharp dip to the south-west. It is composed of detrital quartz and felspar in a volcanic-ash matrix of diabasic character, and is very tough, spec. grav. 2·693. It shades off above and below into grey-green indurated ash-beds.

***418. Tate, Thos.—A Geological Episode as recorded in the Ingleton Granite.**

Trans. Leeds Geol. Assoc., pt. vi., p. 54.

The so-called "Ingleton Granite" is not a granite but a clastic rock, consisting of fragments of slate, chlorite-, mica-, and quartz-schists, pegmatite, quartzites, granitoid rocks and rhyolites, bound together in a green diabasic paste with fresh lath-shaped plagioclase crystals. It appears to be considered an ordinary sedimentary rock.

***419. Tate, T.—Note on Phillips' Dyke, Ingleton.**

Rep. Brit. Assoc. for 1890, p. 814.

The only dyke mentioned by Phillips is 300 yards above Catleap Waterfall. It has a flesh-coloured matrix of orthoclase, hornblende, and idiomorphic biotite, with insets of larger felspar crystals in glomero-porphyritic clusters, surrounded by secondary magnesian mica. It is the best preserved of all the West Yorkshire traps.

***420. Hobson, B.—On the Igneous Rocks of the South of the Isle of Man.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 432, pl. xiv.

The principal locality whence the rocks described have been obtained is round Scarlet Point, and the three following types from elsewhere:—

1. The diabase of Langness intrusive in Silurian slates. The sample is much altered, and there is a diorite with more hornblende, which may be another facies of the same magma.

2. A microgranite (soda-felsite) dyke on a hillside near Crosby, with parallel structure in the salbands, and altering the Silurian slates. The white mica plates are oblique to the foliation, and there are some quartz insets, as also larger ones of plagioclase, &c. In the adjoining slates there are some lines "due to bands of minute black particles," and the brown mica is oblique to the foliation. This foliation may be due to dynamo-metamorphism.

3. Picrite-porphyrite of Poortown, since determined as a diabase, with porphyritic augite in a green ground mass containing plagioclase. The augite is idiomorphic and sometimes forms aggregates.

He also describes a granite, unlike that of Foxdale, one mile west of Port Soderick, and a rock like augite-porphyrite near Poortown. The rocks round Scarlet Point consist of augite-porphyrite and agglomerates, breccias, and tuffs of the same. The first of these forms the Stack, and runs as a dyke N.W. of Scarlet Point, and there is a lava bed tilted so as to be vertical ¼-mile to the west. The Stack is conical and columnar, and the rock is intrusive. Other masses of the same rock are spoken of as lava-beds overlying the agglomerate. These rocks are entangled with Carboniferous Limestone on

the west, and the tuff is inter-stratified with Poolvash limestone. The augite-porphyrite is "allied to the spilite type." The sp. gr. is 2·76. The insets are idiomorphic plagioclase, and the ground mass consists of lath-shaped plagioclase, iron ore, chlorite and titanite, and shows fluxion structure. "Augite is not present in any of the specimens," its former presence being inferred from the chlorite.[1] The tuffs contain three varieties of pumice in a calcareous cement.

Along the N.E. boundary of this group is a melaphyre dyke of large plagioclase and augite crystals and pseudomorphs after olivine, in a ground mass of plagioclase, augite, and iron ore, sp. gr. 2·79. It resembles the Lion's Haunch Rock, and is probably of Carboniferous age.

Further east in the limestone are two olivine-dolerite dykes, and others elsewhere. The augite is ophitic. Another example from Langness shows a marked contrast between the insets and the ground mass; the former are olivine and plagioclase, the latter shows hyalopilitic structure.

421. Hatch, F. H.—On some West Yorkshire Mica-Trap Dykes.

Rep. Brit. Assoc. for 1890, p. 813.

Details are given in the Survey Memoir of the district [No. **92**].

The mica of these rocks is a dark brown biotite, probably meroxene, with needles of apatite. The calcareous matter is in the form of pseudomorphs after augite and olivine. There is very little felspar, but more chlorite from the decomposition of the biotite.

***422. Harker, A.—Petrological Notes on some of the Larger Boulders on the Beach South of Flamborough Head.**

Proc. Yorkshire Geol. and Polyt. Soc., vol. xi., pt. iii., p. 409.

Certain of these boulders can be definitely assigned to Norwegian rocks. These include two types of augite-syenite, like those near Christiania; also the so-called saussurite-gabbro, from South-west Norway. There is also a rock which resembles the "highly metamorphosed volcanic agglomerates" near Shap, or it may be a "dynamo-metamorphic product" from Norway; a hornblende-gneiss, a finer-grained biotite-gneiss. There are also described a strained biotite-granite, and one of finer grain with microcline; quartz-porphyries whose nearest, but not necessarily actual, home would be the Lake District; a very felspathic grit, almost an arkose, like those from the alteration zone near Shap; a hypersthene-

[1] If this be the case, is "augite-porphyritic" a very good name for the rock?

andesite, like those in the Cheviots; andesitic lavas, or porphyrites, with possibly allanite, like types in the Cheviots and Southern Scotland; two rocks very like the Eycott Hill lava; an augite-porphyrite, not recognised *in situ* in the North of England; four varieties of the Whinsill of Teesdale; an olivine-bearing dolerite, not known in the North of England; and a rock like moss agate. He also notices a Carboniferous Limestone boulder, with some shallow pits, produced by solution when pressed by adjoining pebbles.

***423. Cole, Grenville A. J.—The Variolite of Ceryg Gwladys, Anglesey.**

Scient. Proc. Roy. Dublin Soc., vol. vii., n.s., pt. ii., p. 112, pl. x.

This is the only known British Variolite.[1] It has been described by J. F. Blake as "running into the crevices and wrapping round the surface of a purple calcareous rock." This calcareous rock is not, however, an independent one, but the decomposed centre of spheroids of lava, whose surface is variolitic. These spheroids are cracked and jointed, and calcite so coats the joint blocks that they look like limestone, but are diabase within. Elsewhere, however, the whole interior has become jasper, the variolitic crust being unattacked. This jasper in one case preserves the flow-structure of the original lava, and is rendered of sp. gr. 3·13 by the ferric decomposition products. The specific gravity of the variolitic crust is 2·71. The amygdaloidal vesicles are rare, and it is not to these, as supposed by J. F. Blake, that the spotted appearance is due, but to the spherulites. The porphyritic crystals, with the exception of a possible augite, are referred to olivine. They are much corroded and largely replaced by epidote, the outlines are hexagonal, the obtuse angles varying from 134° 20′ to 144° 25′, and the two smaller angles from 67° 30′ to 90° 40′. The replacement of olivine by epidote has not been previously recorded, nor is the typical French variolite produced from olivine-bearing rocks. The spherulites have a dusky border, and the microlithic felt is preserved even in the jaspery parts.

***424. Hill, E., and Bonney, T. G.—On the North-West Region of Charnwood Forest, with other Notes.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 78.

It is stated that the second author is responsible for all the microscopic evidence. The rocks of Peldar Tor, Sharpley, and Bardon Hill had all been considered pyroclastic in former papers—chiefly on account of their resemblance to the porphy-

[1] This is no longer the case, an Irish example having been recently described by the same author.

roids of the Ardennes. These, however, having now been examined by the second author, he considers them to be igneous, and consequently those of Charnwood may be also igneous. Some details are then given of the Peldar Tor rock and its representative at Bardon Hill. The only statement bearing on its igneous character is that in one place a slightly more compact variety gives a very faint indication of fluidal structure. A mean analysis of this rock by Miss **E. Aston** gives SiO_2 71·56, Al_2O_3 10·46, Fe_2O_3 3·95, FeO 2·23, CaO 5·39, MgO 5·72, Na_2O 1·93, K_2O 0·84 = 99·08. There appear to be no new facts bearing on the origin of the Sharpley rock, but the brecciated appearance the authors now believe due to pressure, and the passage into true porphyroid to be at the edge of the lava flow. In one sample of this there was SiO_2 77·8, Na_2O 2·43, and K_2O 2·18, but the average silica is probably 70 per cent.; "thus the rock represents an ancient dacite rather than a rhyolite." The parallelogram-like areas occupied by these two rocks suggest lava flows. A rock near Cadman Wood which has a dyke-like outcrop resembles one or other of the above rocks. The Swanymote Rock contains fragments of slate, &c., in a Sharpley-rock-like matrix—it may be at the edge of the flow. No scoriaceous fragments have ever been met with.

They recognise now at Bardon Hill that their former "shaly bands" are crush-bands. The succession upwards here is—breccia, agglomerate, brecciated rock, passing into green felstone-like rock, purple red breccia, yellowish green breccia, pinker breccia, Sharpley porphyroid, Peldar rock. The porphyroid is described, but there is nothing distinctive to prove it a tuff, which yet it may be. On the whole, though appearances point either way, they "still incline to the view of a pyroclastic origin for the main mass." A mean analysis by **Mr. Lord** gives SiO_2 59·43, Al_2O_3 16·00, Fe_2O_3 4·48, FeO 3·67, CaO 8·03, MgO 4·05, K_2O 1·27, Na_2O 2·22 = 98·65.

The following miscellaneous notes are also made :—

The rock at Stable Quarry, Bradgate Park, called "spotted slate," and formerly considered to be altered by contact-metamorphism, may be a dyke. The igneous junction in Steward's Hay Wood may also possibly be explained by a dyke, but a true igneous intrusion has been found in a loose block. In Whittle Hill Quarry is a large ovoid body bounded by a dusty zone, of which they can suggest no origin. In Brazil wood, three specimens in a line perpendicular to a granite band now visible have been examined. About 30 yards away, there are tiny plates of brown and white? mica, and long trailing aggregates of brown mica flakes making the rock streaky; at 20 yards the white mica is much

larger and garnets appear, and near the junction the rock is still coarser. A few new localities of the Blackbrook group are noted; four particular kinds of pebble in the agglomerates are called purple porphyritic, compact purple, porcellaneous and syenitoid; very few quartzites are found. No glacially-rounded rocks are seen, but there are scattered blocks in places whither they could only be brought by ice. They now think the age of the clastic series is Pebidian, as they believe this, and not Cambrian, to be the age of the early volcanic products elsewhere. The intrusive rocks were injected before the great earth movements which produced the cleavage.

***425. Bonney, T. G.—Note on a Contact-Structure in the Syenite of Bradgate Park.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 101.

A junction specimen of syenite and pale-green argillite at Bradgate shows the latter only baked. The former has a micro-granular border, succeeded by felspar and quartz grains, with speckled matrix, and in places this has a subspherulitic, trachytic aspect. This indicates the introduction of the rock at a low temperature, and half solid. After passing in review the various methods of solidification, the author concludes that a graphic structure indicates a low temperature, as the magma was slowly crystallising, and its molecules could not travel far. This structure is set up, perhaps exclusively, in porphyritic rocks. The Charnwood syenites are normally micrographic, and have little contact effect. The Mount Sorrel granite is holocrystalline to its edge and has very marked effect. At the margin of some holocrystalline vein granites is seen a quartz-felspar mosaic, like that in some Archæan granitoid gneisses, and this he considers due to "constrained crystallisation."

***426. Rutley, F.—On some of the Melaphyres of Caradoc, with Notes on the Associated Felsites.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 534, pl. xix.

The melaphyre series includes—1. An altered vesicular basalt-glass near the summit. The glass is devitrified by microliths, &c., and there are corroded lath-shaped felspars. The vesicles are numerous and irregular. They are filled with quartz, delessite, calcite, chalcedony, and perhaps felspar. It is the superficial portion of an old lava-flow of basalt. 2. Melaphyre tuff at the summit. The fragments are of rocks like the last, but are bordered with magnetite, or filled with it, rendering the rock magnetic. This shows that they have been heated, and were, therefore, probably ejected from a crater as lapilli. They are cemented by chalcedony. 3. Amygdaloidal melaphyre from south-west slopes, with irregularly-arranged felspars. 4. Another of fine texture

shows a pilotaxitic structure, which, before devitrification, may have been hyalopilitic. 5. Melaphyre from south-east slope, more coarsely crystalline. 6. Little Caradoc, a dolerite of dark-green augite and greyish felspar. Possibly this may represent the plug whence the others have come.

The felsitic series shows, very obscurely, a rhyolitic structure, but one of the felsites, above Caradoc Coppice, exhibits an obscure perlitic structure, and many contain small spherulites. Fluxion structure can be better observed in the field, where the amygdules are seen to have been elongated. The best fluxion structure is seen in the fragments in a rhyolite-tuff at the Gaerstones. They probably all form part of one great series of lavas and tuffs.

The plate gives 7 figures of the various structures.

***427. Worth, R. N.—Notes on some Rocks of North Devon.**

Rep. and Trans. Devonshire Assoc., vol. xxiii., p. 400.

The loose blocks of rock at Rockham Bay are not the torn off fragments of an undiscovered porphyry dyke, as has been suggested, for they consist of a great variety of rocks, and the author considers they may be "to some extent derived from the denuded superstructure of the ancient" Dartmoor "volcano." He soon gathered 50 varieties, the most important being yellowish brown granite, greenish-grey schorlaceous granite, and various coloured felspar porphyries. Most of these can be matched on Dartmoor. There are also grits and quartzites, dolerites, and a hypersthene-augite-andesite. The last has been examined by **T. G. Bonney**, who states that it had a glassy matrix, with corroded felspars, augite, and a rather fibrous greenish mineral which may have replaced hypersthene.

Some other notes are given about Lundy Island, whence he has received some specimens of stones. Four-fifths of it is granite, mostly white. There is also a quartz-felspar porphyry. At the south end are dark grey, slightly micaceous slates, and numerous dykes of epidiorite and olivine-dolerite cross from east to west. Some pebbles in the beach at the landing place are also described. He thinks the Saunton Boulder may not perhaps be of glacial origin, as some approach to it is made by the Portledge vein.

***428. Bonney, T. G., and McMahon, C. A.—Results of an Examination of the Crystalline Rocks of the Lizard District.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 464, pl. xvi.

The first author, in 1883, advocated the view "that the crystalline schists of the Lizard were in the main of sedimentary origin," while the second, in 1889, "maintained the igneous origin of many of the foliated crystalline rocks." They now "bear united testimony to the facts of nature."

I. *The Serpentine.*—Of this four new analyses by **M. W. Travers** and all the former ones are given. The new are:—I., from the Rill; II., from Gew Graze; III., from Lower Predannach; IV., weathered ditto:—

	I.	II.	III.	IV.
SiO_2	41·43	42·89	40·29	58·90
Al_2O_3	7·29	0·76	5·10	3·99
Fe_2O_3	7·87	6·30	4·94	2·32
FeO	0·87	3·83	3·98	3·76
CaO	1·88		11.85	
MgO	32·73	38·09	25·67	26·80
Water and loss ..	7·93	7·98	8·17	2·91
	100·00	99·85	100·00	98·68

The minerals in 30 examples are:—Olivine in 12, Enstatite in 14, Augite in 6, Hornblende in 15, Chlorite in 5, Iron oxides in all, and Spinellids in 17. Examples are then given of places where the intrusion of the Serpentine into the "Granulitic" and "Hornblendic" series has not been obliterated. The authors agree that at Porthalla there is not a passage from Serpentine to Hornblende schist, but the former may be somewhat banded near the junction, and was originally fine grained; the latter is considerably altered, and the two rocks may resemble each other so closely "that by the unaided eye alone they can hardly be distinguished"—but the difference is obvious microscopically. A banded specimen from this spot is figured in the plate; it is said to present "a very close resemblance to the fluxion structure of a felstone." The banding generally is caused by a variation in the amounts of a "semi-transparent" "alumina-silicate" in minute granules, of opacite and of chlorite. "Thin slices show that the apparent foliation is due to the streaky condition of the parent rock, differences in the original composition of the streaks being now represented by slight mineral and structural differences in the resulting serpentine. In the opinion of the authors the structure can only be explained as a fluxion-structure." Other examples are then given, where some of the minerals have locally a common orientation.

II. *Rocks older than the Serpentine.*—The Granulitic group consists of dark dioritic rock, veined or interbanded by a rock resembling a fine-grained granite; the former may be brecciated where the latter veins it, or they may be interstratified for considerable distances, and pass rapidly one into the other, and the fragments in the first case may be gradually lengthened till they become streaks or bands. There are no signs of pressure. Their "hypothesis" is that an acid magma was injected into a more basic one, which it either broke or softened, and this latter was drawn out into streaks

when movements occurred, and afterwards the whole mass became crystalline.

The Hornblendic group includes well-banded schists, with an appearance of stratification. Some may be porphyritic dolerite altered by pressure, but the "false bedding" can be better explained as the stratification of an ash, with subsequent rearrangement of the constituents.

The Micaceous group shows both on the large and microscopic scale many indications of crushing, and parts may be traced passing into hornblende schists. The authors, therefore, no longer wish to separate these two groups from one another.

III. *Igneous Rocks Newer than the Serpentine.*—The gabbro is the principal rock discussed, particularly the origin of its banding. This is independent of that of the serpentine, which shows no signs of pressure where the banding occurs in the gabbro. The foliation is very sporadic, sometimes at the side of a dyke, sometimes near the bend of a vein, and thus occurs in neighbouring spots in different directions. It cannot, therefore, be due to shearing after consolidation, and the authors account for it by crystals having been already formed before the motion ceased, and then deformed and aggregated in streaks. Varieties of the gabbro, the troctolite, later intrusive rocks, and some fragmentary inclusions are also noticed.[1]

429. Clark, Thos.—Notes on the Lizard Rocks.

Journ. Royal Inst. Cornwall, vol. x., pt. ii., p. 393, plate D.

The author thinks the hornblendic gneisses are connected with the gabbros and are volcanic. He figures a slide showing radiating cracks proceeding from olivine masses and forming "anthophyllite" in the felspar; next comes a slide in which more "anthophyllite" surrounds or streams from olivine. The cracks are credited to the "expansive power" of olivine on decomposition.[2] A pumice, now filled with jasper and an obsidian are mentioned. A small dyke at Dean Point and another at Coverack have yielded metallic iron which was found to be malleable. He has also tested the magnetism of these rocks, and illustrates it by the deflection of the com-

[1] It cannot fail to be noticed how different are the conclusions now arrived at from those enunciated by the first author in 1883. This change of view is the result of the modification which has taken place since that date in the general ideas entertained by geologists on the nature and origin of crystalline schists. It would appear from this that the Lizard schists themselves have not yielded independent evidence leading to firm conclusions, but the distinguishing characters of schists, as of igneous or aqueous origin, have to be found elsewhere.

[2] The figures are so diagrammatic and the phraseology so different from that usually employed by petrographers, that it is difficult to interpret the ideas here expressed.

pass, but without notes as to magnitude; he has also weighed samples first with, and then without, a magnet suspended "horizontally a short distance over." The weight of the Manacle rocks was thus reduced by $\frac{1}{3000}$, while the Black Serpentine from Cadgwith was reduced by $\frac{1}{18}$.

***430. Fox, Howard.—The Cavouga Boulder.**

Trans. Roy. Geol. Soc. Cornwall, vol. xi., p. 334, with two plates.

This is not a glacial boulder but a loose block of a porphyritic diorite with large felspar insets. It occurs *in situ* near Cavouga rocks, and at West Kennack on the sea-shore at half-tide.

***431. Fox, Howard.—Picotite in Serpentine.**

Trans. Roy. Geol. Soc. Cornwall, vol. xi., p. 336.

Serpentines with picotite are greenish grey, and the crystals often weather in ridges, as at 240 yards N. of Polbream Point, between Kennack and Lankidden, on the east side of Lankidden Cove and in the cliff north of Butter Cove, &c. **J. J. H. Teall** describes the latter as containing black resinous-looking patches with chromium reaction and hardness 8, hence they are picotite.

***432. Teall, J. J. H.—On an Eclogite from Loch Duich.**

Miner. Mag., vol. ix., No. 43, p. 217.

The rock is believed to be part of the thrust Archæan gneiss. It consists essentially of garnet and omphacite. The garnet is almandine with its cracks penetrated by hornblende and with epidote in patches. The omphacite is pale green, with the cleavage and optical properties of pyroxene, but without definite crystalline form. Hornblende forms a zone separating these two minerals, and micropegmatitic intergrowths of omphacite and felspar form part of the ground mass.

***433. Harker, A.—On Various Crystalline Rocks (Woodwardian Museum Notes).**

Geol. Mag., Dec. 3, vol. viii., p. 169.

The third specimen referred to is a British Rock, viz., a garnet amphibolite from Sutherland. This occurs three miles S. of Laxford Bridge. It consists of one-half green hornblende and a large number of red garnets, cracked in a parallel direction, *i.e.*, perpendicular to the direction of stretching; the other ingredients are felspar and interstitial quartz.

***434. Teall, J. J. H.—On a Microgranite containing Riebeckite from Ailsa Crag.**

Miner. Mag., vol. ix., No. 43, p. 219.

The rock is spotted with irregular blotches of a dark blue colour, which are aggregates of a dark blue mineral and

quartz and idiomorphic felspar. This dark mineral is the riebeckite wedged in between the felspars. It has hornblende cleavages and is very absorptive. Its colours are α and $\beta=$ deep blue, $\gamma=$ yellowish and greenish brown, angle of extinction very small and the greatest axis of elasticity nearly coincides with the vertical axis, which are the characters of riebeckite. The quartz is interstitial and the felspar appears to be a soda-felspar.

435. Dow, R.—Tertiary Dykes of the Lower Tay Valley and District around Perth.

Trans. and Proc. Perthshire Soc. of Nat. Sc., vol. i., p. 226.

A 50-ft. dyke of basalt, weathering into subrectangular blocks, is seen at the Linn of Campsie, and another crosses it near Stobhall Castle. Two miles below is the Thistlebridge Dyke, used for road metal; there are also two others, not previously noticed, in the bed of the river. No more are seen till the Luncarty district is reached, where one crosses the Almond at Lynedoch, and another crosses the Tay at Waulkmill.

In the neighbourhood of Perth are seven dykes, viz., at Coasie Hill, Windyedge, Pitroddie, Newhouse, Hill of Ruthven, Scoonieburn and Craigend. All these have very straight sides, and have considerable contact effect.

***436. Lindsay, Jas.—Some Basic Dykes in Ayrshire.**

Glasgow: 8vo, pp. 14.

This deals with some of the gregarious dykes that are to be seen along the coast:—1. Just south of Largs are six dykes in conglomerate; the largest has porphyritic crystals of olivine, with lath-shaped felspars in the ground mass. 2. At the Largs battery a group of five dykes, the thickest, four yards wide, is composed of augite and felspar. 3. At Portincross Castle is a group of six, also in conglomerate, which they alter for some feet, the largest, of over fifty feet, has abundant felspar. It contains 48·58 of silica and 12·70 of iron oxides, sp. gr. 2·777. Some of these have selvedges. 4. South of Greenan Castle the largest of several is ophitic with augite and felspar. All these rocks contain magnetite. The silica in this is 45·63, and the iron oxides 12·12. These dykes maintain a rectilinear course through a variety of rocks, and irrespective of faults. They are of Tertiary age, and belong to the Mull system.

***437. Sollas, W. J.—Contributions to a Knowledge of the Granites of Leinster.**

Trans. Roy. Irish Acad., vol. xxix., pt. 14.

After an historical sketch, the author explains his method of separating the constituent minerals. The ground material

is passed through a sieve of 16 meshes to the square mm., and the finest "flour" removed by levigation. The rest is placed in Thoulet's solution, sp. gr. 2·715, in a special form of Smeeth's separator, placed at first obliquely. The sp. gr. of the fluid is determined by mercury floats with a long capillary termination, the distance of whose end from the surface of the liquid gives a measure of the density. The sp. gr. of a given mineral is obtained by pouring, first, a denser fluid, and then a less dense one into a glass tube, and allowing the two to diffuse so as to produce a column of gradually increasing density downwards, whose change is shown to be regular by the straightness of the spectral bands produced. Two minerals of known sp. gr. are floated in this, and the mineral to be tested floats between them in a position proportional to the difference of density from the known ones. By taking a series of solutions of sp. gr.—2·715, 2·68, 2·65, 2·64, 2·6, 2·57, and 2·52—overlying in order, and pouring in the powdered rock, the various minerals sort themselves out.

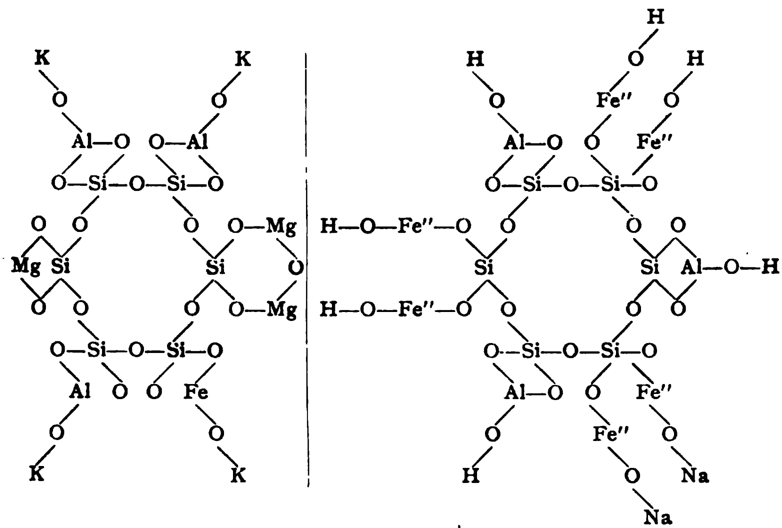
The constituent minerals are—1. *Zircon*, with gas cavities but no glass inclusions. It occurs most abundantly in biotite, and contains rods which may be rutile. It has always a pleochroic aureole. 2. *Apatite*, banded, and violet in the centre. It is commonest in biotite, and never has a pleochroic aureole. 3. *Biotite*, in idiomorphic plates, in all the later constituents, specially in muscovite. It is of the species Haughtonite. He gives an analysis of a sample from Aughrim, and compares it with older analyses—SiO_2 33·95, TiO_2 3·81, Al_2O_3 17·13, Fe_2O_3 2·44, FeO 21·18, CaO 2·03, MgO 6·60, K_2O 7·12, Na_2O 2·83, H_2O 3·70, P_2O_5 0·68 = 101·47. This leads to the empirical formula—

$$Si_{12}Ac_7Ms_9Ha_{18}O_{48},$$

where Ac Ms and Ha stand for triad, dyad, and monad elements respectively. Interpreting this according to Tschermak's hypotheses, the essence of which is the existence of a silica ring, the free affinities of which are satisfied by groups of the form $\begin{matrix}O\\O\end{matrix}\!\!>\!Ac—O—Ha$, or other corresponding form. He considers the Aughrim biotite to contain two types of molecules (see next page).

The other analyses he treats in the same way. The alteration of colour may be due to the conversion of the rays $\begin{matrix}—Fe\\—Fe\end{matrix}\!\!>\!O$ into —Fe—O—H, and the final bleaching to the conversion of the latter into —H. On treating with HCl, a model in silica is left, as if all the free O affinities were satisfied by H, leaving the silica ring unbroken; but the spec. grav. of the silica obtained —1·98 corresponds to $S_{16}O_{10}(HO)_4$.

The same mica may, however, be represented by an aluminous nucleus Al$\left\langle\begin{matrix}O-Si= \\ O-Si= \\ O-Si=\end{matrix}\right.$ the free affinities being satisfied in different ways (Clarke's theory). In this case the residual silica should be SiO_4H_4, which also gives the wrong spec. gravity. 4. *Muscovite* occurs in idiomorphic six-sided plates, with inclusions of parallel flakes of biotite, which are often corroded, and arranged zonally. The muscovite is also zonal itself, the axial angle increasing in one case from 56° 45′ in the interior to 58° 40′ near the edge, showing a radial decrease in the biotite material. 5. *Soda-Lime Felspars.*—These vary from oligoclase to albite. An andesine, s. g. 2·684, gave SiO_2 57·04, Al_2O_3 27·69, CaO 9·18, alkalies by diff. 4·59, loss 1·17, and another gave potash 0·87, soda 6·83. An albite gave soda 8·708, and potash 1·741, and another



SiO_2 67·17, Al_2O_3 20·50, Fe_2O_3 0·22, CaO 1·61, Na_2O 10·16, K_2O 0·65, H_2O 0·31 = 100·62; a third, sp. gr. 2·615, gave soda 8·084, potash 4·205. Zonal structure is very perfect. "The outermost zone will frequently extinguish at . . . 14°. The angle diminishes . . . towards the centre till it becomes zero; up to this point we may speak of the angle as positive; beyond it, as the crystal is rotated, the angle of extinction increases towards the centre till it may reach . . . 24°. This extinction on this side of zero we may distinguish as negative." This may be accounted for on Hoffner's hypothesis of the centre being more basic, or on Levy's of

being dependent on ultramicroscopic twinning after the albite and pericline plans; both views have a certain amount of support. 6. *Microcline* is in some cases formed before the quartz, but mostly later, occurring in cracks of quartz, and round micropegmatitic felspars. It consists wholly of potash felspars when pure. 7. *Orthoclase* is very rare. 8. *Quartz* is remarkably free from inclusions, where intergrown with felspar it "simulates, with an extraordinary degree of resemblance, the canal system of Eozoon," and a similar canal system he has been able to produce by freezing a mixture of gelatine and water.

General Structure.—The rock of Ballynamuddagh is a granitite, the biotite being resorbed and replaced by felspar. From the analysis, it is calculated to contain anorthite molecules 17 per cent., albite 27·1 per cent., variously mixed, and orthoclase (not microcline) 11·6 per cent. It shows signs of pressure. The rock of Carnsore is also a granitite, with only secondary muscovite. It contains anorthite 8·8 per cent., albite 24·4 per cent., microcline, 23·3 per cent.—sometimes in zones. The quartz often shows striæ and banding, like those found by Professor Judd in large crystals, and referred to mechanical pressure. This is the first record of such a structure in the quartz of igneous rocks.

The other granitic rocks are true granites. The soda granite of Aughrim contains SiO_2 70·69, Al_2O_3 15·20, Fe_2O_3 3·76, CaO 3·31, MgO 0·45, K_2O 2·31, Na_2O 4·69, H_2O 0·56, = 101·07. The percentages of the various minerals have been determined by sketching each as seen in a thin slice, weighing tinfoil cut to corresponding shapes and multiplying by the respective sp. gravities, giving sphene and epidote 0·546, primary mica 7,328 zonal felspar 51·143, microcline 9·193, quartz 31·790. By calculation from the analysis there is orthoclase (or microcline) 10·56, albite 37·86, anorthite 14·56. The mineral he formerly called allanite is not so, it may be zoisite.

He then describes six microgranitic dykes, one of these contains SiO_2 71·78, Al_2O_3 15·86, Fe_2O_3 4·19, CaO 3·16, MgO 0·50, K_2O 1·13, Na_2O 4·1, loss 1·17 = 101·89. They are off-shoots from the granite. There are also veins of white granite of later origin, sometimes penetrating cracks in the original minerals. The granite is altered at its junction with the schists, but mostly by subaerial waters, it was injected after the cleavage of the schists. The latter contain muscovite, biotite, and andalusite near the junction, and the first of these within a foot is broken up with chlorite and quartz. The Cushbaun rock contains orthoclase (not microcline) 7·87, albite 26·73, anorthite 13·35. It is intermediate between granitite and granite. The Coolboy rock contains orthoclase 9·88, albite 41·1, anorthite 11·8. It does not alter the

adjacent schists. The Ballynaclash rock contains orthoclase 11·09, albite 32·71, anorthite 9·29, but there is much sphene present. The Crogan Kinshala Rock shows microperthitic and micropegmatitic structure, and has been much pressed. The Little Arklow rock has been already described by Haughton and Hatch. The potash granite of Ballyknockan contains orthoclase 24·32, albite 18·60, anorthite 11·28; the two latter are probably mostly combined as oligoclase. The quartz contains filamentary crystals. The Three Rock granite is coarse, it contains mica 8·93, soda-lime felspar 39·33 (possibly too high), microcline 15·59 (possibly too low), quartz 36·16. The felspars are: potash felspar 25·22 (possibly combined with the others), soda felspar 24·95, lime felspar 7·59. The Blackstairs rock contains orthoclase 27·72, albite 26·05, anorthite 4·11. The albite is eroded by microcline, and the rock is much pressed. The Rockabill rock contains mica 6·47, felspar 67·48, quartz 26·05. There is 5·236 of potash and 3·587 of soda, orthoclase (mostly microcline) 30·23, albite 29·50, anorthite 2·94. This shows a crystal of biotite, with its fibres penetrating the cleavage planes of albite. The gneissose granite of Sanns Mount resembles the Three Rock granite in composition; it has large sheets of both micas undulating round cracked and distorted microcline. The Scalp granite is most gneissose near the schists; its composition is like that of St. Ann's rock. It shows numerous gliding surfaces of both micas round felspar-crystals, aggregates, or narrower pieces of quartz, forming "phacoids." There is a quartz mosaic in the angles. All the minerals show signs of pressure, the felspars are cracked perpendicularly to the gliding surfaces, but the micas are not chemically altered. This crushed granite was originally not different from the rest. It had consolidated previous to the pressure, which was post-Ordovician. The probable reason why the hard quartz has been more broken than the felspar is its great brittleness.

In the whole series it is probable that from $\frac{1}{10}$ to $\frac{1}{5}$ of the felspar has been converted into muscovite. One-third of the silica is certainly free—in spite of the presence of biotite and magnetite. Soda lime felspar on the whole vastly exceeds the potash-felspar.

The order of consolidation of the minerals was rutile ?, zircon, apatite, magnetite, biotite which is not homogeneous, as shown by the aureoles round the zircons, muscovite formed in many stages when present, anorthite gradually changing to albite—this brings one chapter to a close. The microcline and quartz are not constant in their order, and are sometimes simultaneous. There is in these rocks "a succession of stages, each of which was preyed upon by the

next succeeding, thus:—A stage of iron-ores which under favourable circumstances might conceivably give rise to a deposit of magnetite, &c., of biotite resulting from the interaction of magma and iron ores, which might give rise to an iron-ore-biotite rock; of muscovite, evidently a very transitory one; of basic felspars, which become eaten up by the succeeding more acid members." [Auct. in lit.]

***438. Hull, E.; Nolan, J.; McHenry, A.; Kilroe, J. R.; Egan, F. W.; Cruise, R. J.—Explanatory Memoir to accompany Sheets 3, &c.**

Geol. Survey of Ireland, chaps. vi.—x.

Deals with the igneous rocks of N.W. Donegal.

Chapter VI. *Granite.*—In the Glen and Lough Beagh district this is described as "including occasional bands of quartzite schist and crystalline limestone"; a section in Barnesbeg gap shows "beds of granite interbedded with schist." "Intrusive sheets" are also spoken of. At Lackagh Bridge foliated granite "gives place to gneissose schist, bands of limestone, hornblende schist, and quartzite in a nearly vertical position, and where the river opens out on the strand the quartzites gradually predominate."[1] In the Falcarragh district the granite is porphyritic with pegmatite veins, and traverses the schists along their foliation planes. In Glenfin and Glendowan it contains caught-up masses of schists, limestones, and diorites, which it alters; idocrase and garnet are developed in the limestone, and all are sheared together subsequently. In the Gweedore and Dungloe districts the foliated and non-foliated portions unite along a definite zone, but without any sharp boundary, and the foliated granite sends tongues into the adjoining metamorphic rocks. At Bunbeg, the granite is a coarse, red rock, and is crossed by "elvan veins." In Bloody Foreland it likewise sends veins into the schist across the foliation, and in Gola Island forms natural arches. On Inishbofen, it is coarse and porphyritic. In Binanea it intrudes into quartzite, and pegmatite veins are formed along the bedding of the schists. In Roscuill district it is plainly intrusive, and contains numerous blocks of the metamorphic rocks. In Fanad Head it is principally red, but in places becomes dark grey, and its edges are entangled in the quartzite. In some places the flesh-coloured orthoclase contains inclusions of red, and the grey, inclusions of pink,—pointing to stages in its consolidation. To the W. of Doocharry a section is given in which there are bands of finer-grained granite, alternating

[1] All this reads as though the granite were a gneiss in beds with the schists, as the writer of the description (E. Hull) previously thought but it is now believed to be in "intrusive sheets."

with the ordinary grey, and both intruded upon later by a cross-vein of non-foliated granite. These bands "radiate from larger masses, and dovetail into the adjoining granite in such a way as to preclude the supposition that they are merely heterogeneous portions of the same mass." In Mullaghderg, as already described by F. H. Hatch, there are spheroids closely packed with a nucleus of grey crystalline plagioclase, surrounded by pyramidal crystals of the same, radially arranged, forming a shell.

Chapter VII., *Felstone (Felsite) and Felstone Porphyry.*—The dykes of these rocks are the newest in the district, they are entirely unfoliated, and by the variation of the hornblende present, verge towards syenite on the one hand and minette on the other. They are numerous and wide in Dunfanaghy and Horn Head, but less numerous in Fanad. They run parallel to the bedding of the schists in Ardmore, and in the north end of Cruit, where one crosses the granite, it forms a natural arch by its decay; the jointing is here oblique to the walls. In the Foreland coast the numerous dykes contain quartz, and there are narrower dykes of mica trap. In Aran Island are masses of "syenite," and the Tor at the north is of sphene-bearing hornblende-granitite. Intrusive sheets and dykes of hornblendic felsite occur in the metamorphic schists in Stranorlar.

Chapter VIII., *Diorite* and *Epidiorite.*—These rocks, though intrusive, follow the planes of bedding at several horizons in the quartzites, schists, and limestones. In the Fanad district are several dykes at "Seven Arches"; but these arches are produced by the weathering of the quartzite along joints. The mass at Murrian may be a "neck." At Keadew Bay, white felspar is porphyritic. The dykes only occasionally show any foliation. In the Ards district there are several necks and two conspicuous sheets above and below the Ards limestone. In the Glenfin district the sheet just below the quartzite is very coarsely crystalline, and it is foliated with the schists, becoming in the granite a hornblende-schist. In the Gweedore district diorite flanks the north-western side of the quartzitic chain, and its intrusion in the schist is seen. At Lough Altan, the dyke is crystalline in the centre and foliated at the sides. Similar dykes and masses occur in the Dungloe district, in Horn Head and in Stranorlar, in the last some are partially augitic and are called schistose epidiorite.

Chapter IX., *Basalt (Dolerite) Dykes.*—These are black, compact, spheroidal, and amygdaloidal, numerous, and comparatively narrow; they run along the jointing of the granite in a N.W. or N.N.W. direction. Examples are mentioned in most of the districts.

Chapter X. describes Tory Island. It chiefly consists of

granite in which patches of other rocks are caught up. In structure the granite is coarse and in colour red or grey. Felstones and basalts occur in dykes and the Doon peninsula is made of tabular white compact quartzite.

439. Hyland, J. S.—Petrographical Notes.

Appendix to the above.

These notes have been made from specimens collected independently of the survey of the district. The rocks described are:—

1. *Granites.*—Many are intensely foliated by the orientation of white mica, and some possess a *flaser* structure, defined by streaks of dark mica and lenticles of quartzo-felspathic material. Regional metamorphism is shown by granulation. When the dark mica becomes decomposed, it shows numerous inclusions of rutile needles arranged in the hexagonal meshes called sagenite. A reddish mica contains rod-shaped *vitreous* inclusions, which are devitrified in the usual manner. The zircons enclosed in the same micas show pleochroic halos. When the granites have been intensely sheared, as in that of Barnesbeg Gap, all sign of the original granitic structure is lost, in its place microcline of secondary origin occurs, and induced lamellation of the plagioclases. In the centre of the lenticles there is also an irregular grain of microcline. Quartz crystals which in ordinary light show no alteration, are found under crossed nicols to be granular.

In the hornblende-biotite-granites, the felspars are often zoned, the inside being decomposed, the outside clear. The hornblende is alone or in aggregates and is green; almost all these rocks contain sphene in well-formed crystals. It is amongst these that the spheroid-bearing granite occurs, but very little granulation or foliation is observed in them.

2. *Pegmatites.*—Only one, from Tory Island, is described, in which the structure is entirely microscopic, and no other minerals than quartz and felspar are present.

3. *Augite-syenites.*—The only example is from Three Tops Mountain; augite and biotite are present in about equal quantities.[1] The augite is monoclinic and is seen to be altering to green hornblende, sometimes mica is enclosed in it, and sometimes *vice versâ*. The principal felspar is orthoclase, and a small amount of quartz is observable, some of which is secondary. The rock is non-foliated.

4. *Diorites.*—The hornblende in one case is green, in others brown, it alters to dark mica, and has secondary feathery outgrowths. Very little striated felspar can be observed, but the structure is dioritic. The amount of felspar varies much —a phenomenon which is ascribed to a segregation process.

[1] Why is it called a syenite?

5. *Lamprophyres.*—Two rocks are described with the habit of the Lamprophyre family; they consist of two essential minerals, hornblende and orthoclase; they belong to the amphibole-vosgesites, a rock-type hitherto unknown in Ireland.

6. *Felstones* and *Felstone Porphyries*—These contain porphyritic felspar, with biotite, hornblende and quartz. The ground mass is micro- or crypto-crystalline or may even rise to the texture of a micro-granite. Granophyric structure is occasionally seen. Sixteen rocks of this description are mentioned.

7. *Plagioclase-hornblende-augite-olivine Rock.*—A single sample of this occurs at Port Salon Pier. It is compact and basaltic in appearance. The olivine is porphyritic, and so is occasionally the augite; the other minerals are in the ground mass. The felspar is lath-shaped and striated, but some may be anorthoclase. The hornblende is brown, and is not at all corroded, but it does not envelop the augite; fluxion structure is apparent, but there is no direct evidence of a glassy residue. He would call it "hornblende-basalt," but that the name is appropriated for a rock with porphyritic hornblende.

8. *Plagioclase-augite Rocks.*—These are ophitic, and may be divided into the olivine-free or proterobases, and olivine-dolerites. In the former the augite is seen changing to green hornblende, and ilmenite is surrounded by dark mica. In one place the felspar is pseudo-pegmatitic, the quartz being secondary. The latter are almost completely holocrystalline, and typical in character. The felspar is albitic, the augite reddish-brown, the olivine colourless, and changing to serpentine or calcite. There is a small quantity of interstitial glass, and some that has changed to radially fibrous globules. As Zirkel has pointed out, the presence of large crystals is favourable to devitrification—both indicating the maintenance of the rock for a long period at a high temperature. He notices also the filled-up vesicles forming chalcedonic or glassy spheres.

9. *Epidiorites.*—The hornblende in these is light-coloured, and the more they have been altered, the more there is of it. The felspar has recrystallised in the interstices. When less altered, ophitic structure is still observable, though the felspar may be altered to epidote, &c. The hornblende is fibrous—the fibres polarising differently, and the outline may approach that of a pyroxene unless the fibres have been drawn out to form lenticles. The margins are sometimes a clear actinolite in optical continuity with the interior; altered ilmenite is also present, often edged by chlorite or yellowish-brown mica. Little thrust planes are sometimes seen. At Duntinny the rock is garnetiferous.

10. *Hornblende Schists.*—These with loss of foliation pass into amphibolites, but even these are orientated under the microscope. The rock may be of igneous nature, but all igneous structure, if once present, is now obliterated. There is a surprising amount of plagioclase, striated both on the albitic and pericline type; it is always granular. At Meenalargan Hill the rock appears to be sheared sphene-bearing diorite, the plagioclase in which is not granulated. In other places they are sheared epidiorites.

11. *Biotite-chlorite-epidote Schists* occur at Letterleague.

12. *Mica Schists* at Port Salon pier consist of parallel layers of whitish felspar and yellowish-green mica. The felspar and quartz are granular and pure. In Horn Head they contain two micas intergrown together. Two and a half miles S. of Creeslough, the quartz felspar mosaic is seamed with threads of dark mica. Pleochroic halos are also observed here.

13. A *Phyllite*, three miles E. of Dunfanaghy, shows knots of chlorite scales with quartz and magnetite encased in an aggregate of quartz and fibrous green mica.

14. *Quartzites and Quartz Schists*—Those in Tory Island are pinkish and highly felspathic, and dark mica is not uncommon. The clastic structure is obliterated and a mosaic superinduced. The rocks on the mainland are similar.

15. A *Schistose Grit* at Newtown Tully has pebbles split into differently orientated grains. There are two micas, and the rock is almost a quartz schist.

16. The *Limestones* show no sign of organisms, but are crystalline calcite in twin lamellæ—quartz, darkish mica, green hornblende, and iron pyrites occur. At Lough Aghnish the limestone is serpentinous, but the serpentine is derived from a pyroxene. When caught in the granite, garnet and tremolite are developed.

17. *Old Red Sandstone.*—The quartz fragments are quite sharp.

18. *Soapstone of Croky Head.*—Old analyses are given.

19. The "Boulder Bed" contains pebbles of altered, more or less foliated, granite, quartzite, and dolomite. The matrix consists of greenish mica and finely-granulated felspar and quartz. In the neighbourhood of a granite pebble it will be rich in quartz and reddish felspar—when the pebble is of dolomite the matrix also will be highly dolomitic—the nearer a pebble, the greater the alteration. The schistosity and alteration have been produced in pebbles and matrix together.

***440. Kilroe, J. R.—Explanatory Memoir to accompany the Maps of South West Donegal. Chap. VII. Igneous Rocks.**

Mem. Geol. Survey Ireland.

In this area there are dykes of dolerite and basalt, with a neck at Ardaghy Glebe. The diorite and epidiorite dykes are invaded by and enclosed in the granite, and are of numerous varieties. Felstone dykes are later than all the metamorphic series. They occasionally contain tourmaline, and at Lough Anna become quartz porphyries. There is an intrusive sheet of syenite at Meenaneary. The granites show the following history:—1. Intrusion of the molten mass. 2. Crystallising out of portions rich in pink orthoclase, plagioclase, black mica, and sphene, and invasion of the masses by still molten rock. 3. Crystallisation of this molten rock so as to form the prevailing grey granite of the central portion. 4. Invasion of this mass by bands and dykes of fine-grained granite with black mica and by veins of aplite. 5. Formation of pegmatite. 6. Foliation of finer and coarser grained granite by shearing, and finally invasion of all this by a fine-grained, unsheared white-mica granite.

441. Hyland, J. S.—Petrographical Notes.

Appendix to Explanatory Memoir to accompany the maps of South-West Donegal. Mem. Geol. Surv. Ireland.

Gives the microscopical characters of the following rocks:

1. *Felstones.*—Only one sample is porphyritic with insets of felspar partly altered to mica, and sometimes in aggregates. Sagenite occurs in the mica. The ground mass is cryptocrystalline.

2. *Lamprophyres.*—The ground mass is microgranitic, of brown hornblende and white felspar of unknown character, and occasionally porphyritic; nothing is said about mica. Only one rock of this type is met with, at Teelin.

3. *Felspar-pyroxene-hornblende-sphene Rock* at Cullion, N. shore of Gweebara Estuary. The pyroxene is monoclinic, the hornblende green, and both inclusion-dusted, the latter with yellow-red mica; the sphene is primary; the felspar is doubly striated.

4. *Diorites.*—The hornblende is in large ragged-ended crystals, apparently paramorphic after a monoclinic pyroxene; there are dark micas both within and without, and much sphene at Russel's Ferry. The plagioclasse is squeezed and has rutile-like needles. These are probably allied to gabbros. A rock with the habitus of a lamprophyre but occurring as a sheet at Meenaneary is described here. Its greenish-brown hornblendes alter to chlorite *in the centre,* and at the ends of longitudinal sections have a secondary growth of lighter colour, with a difference of extinction of 3°.

5. *Epidiorite* only occurs at Killybegs, the hornblende being fibrous and the felspar granular, but two others are nearly allied, but have the hornblende massive.

6. *Granulites.*—Two mentioned are platy, with both micas on the planes.

***442. Sollas, W. J.—On a Fragment of Garnet Hornfels.**

Scient. Proc. Roy. Dublin Soc., vol. vii., n.s., pt. i., p. 48.

This is a small fragment from a half-inch band in the Ordovician schists near the granite of Carrickmines. It is a grey rock speckled with garnets, sp. gr. 2·925. Its analysis yields: Silica 48·608, Alumina 21·614, Ferric oxide 10·922, Ferrous oxide 2·261, Manganous oxide 12·090, Lime 0·514, Magnesia 0·050, Soda 3·021, Water 2·104 = 101·194. This brings to mind the "coticule" described by Professor Renard. The garnets have a specific gravity 4·16, and yield Silica 37·63, Alumina 16.43, Ferric oxide 7·85, Ferrous oxide 14·59, Manganous oxide 18·55, Lime 3·49, Magnesia 2·10=100·64. The following formula is adopted for them:—

$$\begin{gathered} 4\,(3\,SiO_2,\ Al_2O_3,\ 3\,MnO) \\ 4\,(3\,SiO_2,\ Al_2O_3,\ 3\,FeO) \\ 3\,SiO_2,\ Fe_2O_3,\ 3\,MgO \\ 3\,SiO_2,\ Fe_2O_3,\ 3\,CaO \end{gathered}$$

They are in rhombic dodecahedra, and have been cracked by the later pressure. They do not include any of the ground mass—and were therefore formed before it, but they contain prisms, apparently of andalusite. The ground mass is much smaller-grained, of green mica, quartz, and felspar—all showing signs of pressure. The green mica yields Silica 35.62, Alumina 16·21, Ferric oxide 22·01, Manganous oxide 16·55, Soda 2·87, Water 6·52=99·78. The constitution is thought to consist of three rays of the form $Si\left\langle\begin{matrix}O\\O\end{matrix}\right\rangle Al{-}O{-}H$, and three of the form $Si\left\langle\begin{matrix}O{-}Mn{-}O{-}H\\O{-}Fe{-}O{-}H\end{matrix}\right.$ two of the H being replaced by Na, and some of the molecules reducing to $Si\left\langle\begin{matrix}O{-}Mn\\O{-}Fe\end{matrix}\right\rangle O$. The rock is probably of Ordovician age, and altered by contact with the granite.

***443. Bonney, T. G.—A Variety of Picrite (Scyelite) in Sark.**

Geol. Mag., Dec. 3, vol. viii., p. 332.

He has now found the rock *in situ*, from which the boulder may have come which he described in 1889 (G.M., vol. vi., p. 109). It occurs intrusive in gneiss at the foot of the cliffs between Port du Moulin and Saignie Bay. The olivine is not so well preserved, and there is rather less mica and more hornblende than in the boulder.

443a. Lapparent, A. de.—Sur la Chronologie des Roches Éruptives à Jersey.

Comptes Rendus, vol. cxiii., p. 603.

The most ancient eruptive rock is an epidiorite, varying

from a kind of diabase to a quartz-diorite. This appears to intrude into the Cambrian slates. This is traversed by veins of the coarsely-crystalline La Moye granite. This granite is crossed by threads of granulite or pink pegmatite, becoming massive at Mont Mado. To the south of St. Helier the granulite passes into a micropegmatite, which is transformed laterally near St. Clement into a spherulitic porphyry, and at Rouge Road the granite changes to syenite. Between these granitoid rocks and the petrosiliceous ones there is a continuous aureole of andesitic porphyrites, sometimes like vert-antique, and sometimes vacuous spilite, and often accompanied by porphyritic tuffs. These spilites are broken up, and form at Havre Giffard the base of the petrosiliceous rocks. At St. Helens they are pierced by a brechiform "orthophyre."

The acid rocks commence with a flow of rhyolite, then come the felsitic porphyries, and then the pyromerides of Boulay Bay, associated with "argilolites," and plunging at Tête les Hougues, below the Silurian conglomerate. All this is crossed by vertical threads of amphibole-porphyry. There is also, at Plémont, a beautiful micaceous porphyry with globular centre, and a granitoid diabase.

He mentions a micropegmatitic structure, set up in granite veins, at Etacq, where the neighbouring "quartzophyllades" have re-crystallised at its approach.[1]

***444. Roberts-Austen, W. C., and Rücker, A. W. On the Specific Heat of Basalt.**

Phil. Mag., ser. v., vol. xxxii., p. 353.

Basalt was melted in a platinum crucible, and the temperature ascertained by an electrical method; it was then immersed in water in a silver calorimeter. The results are, if T = temperature at moment of immersion, C the mean specific heat between about 20° C and T:

T.	C.	T.	C.
467	0·199	860	·277
747	·217	924	·282
759	·223	977	·284
792	·220	983	·283
846	·257	1,090	·285
		1,192	·290

This leads to the following mean specific heats between—

20°— 470° = 0·199.
470°— 750° = ·243.
750°— 880° = ·626.
880°—1,190° = ·323.

Thus "the specific heat of basalt follows the ordinary rule that the specific heat of a substance is greater in the

[1] *See* No. **425.**

liquid than in the solid state. There is a large absorption of heat in the neighbourhood of 800°, which raises the mean specific heat between 750° and 880° to a much larger amount.

METAMORPHISM.

445. Hunt, T. S.—Les schistes cristallins [The Crystalline Schists].

Compte Rendu Congrès Géologique International (1888), p. 65 (published in 1891).

Primary rocks are divisible into crystalline and "porodic." They are also divisible into :—1. Indigenous, which are more or less stratified. 2. Endogenous, formed by deposition in veins. 3. Exotic, forced into veins by displacements when they are pasty. With regard to the first group there are plutonists and neptunists. The "exoplutonic" hypothesis is that all the crystalline schists are eruptive, the "endoplutonic" that they are the products of consolidation of the primary igneous mass of the globe. The "chaotic" hypothesis refers them to successive crystallisations from a primordial chaotic liquid, and the "thermochaotic" imagines the liquid hot. The "metamorphic" theory considers them consolidated and crystallised from previous sediments, but takes no account of the mineral losses occurring previous to sedimentation. The theory that admits additions and su tractions to the sediments, whereby any one set of ingredients may be changed to any other, is the "metasomatic."

His "crenitic" hypothesis is nearest the "chaotic," but as the ingredients could not all be in solution at the same time, he thinks some to have been added by thermal springs. According to this theory the solidified crust is the "veritable mineral protoplasm," which, subjected to the action of water and air, has been penetrated by aqueous currents producing springs, which carried off silica, alumina, and potash, and brought lime, magnesia, and soda, the resulting minerals being separated by their specific gravities! The loss thus occasioned to the protoplasmic mass, and the weight of the crenitic and ordinary sediments, has brought about the contortions and produced the "pseudoplutonic" rocks, *i.e.*, those of crenitic origin, but with the habit of eruptive granite. The interference of other rock-forming agencies has prevented later rocks from having the uniformity of the fundamental crenitic granite, and has produced the transition rocks. Endogenous rocks are of crenitic origin, particularly pegmatites, which are undoubtedly aqueous. At a high temperature and pressure water enters into combination with silicates

forming hydrates. On cooling, the anhydrous salts are deposited, and the disengaged water is emitted in vapour at volcanoes.

He classifies pre-Cambrian rocks as—1. Laurentian, divided into a lower Ottawa and an upper Grenville group. 2. Norian, the norites of which must not be confused with gabbro. 2. Arvonian of petrosilex chiefly. 4. Huronian, corresponding to the Pietri Verdi of the Alps. 5. Montalban, the younger gneisses and mica-schists of the White Mountains, which are recognised also in the Alps and in Scotland. 6. Taconian, consisting of quartzites, lustrous schists, &c., which represents only the lower portion of the Taconic system of Emmons, the upper part being unconformable and fossiliferous. The differences between these six groups are more noticeable than their resemblances, and in particular the simple silicates, such as andalusite, are found only in the higher ones. The Animike series of Lake Superior is equivalent to the Taconian, and the Keweenian is higher than them all.

***446. Heim, A.—Zur Klassification der Krystallinischen Schiefer [Notes on the Classification of the Crystalline Schists].**

Compte Rendu Congrès Géologique International (1888), p. 80.

There is a special difficulty in the study of crystalline schists, owing to the "mechanical deformation of rocks by mountain making." The changes can best be seen in the undoubtedly sedimentary rocks in which the foldings have produced, 1, the deformation of fossils, pebbles and crystals; 2, cleavage; 3, cleavage with "linear stretching"; 4, small folds; 5, internal breccias cemented by mineral deposits; 6, internal gliding surfaces, which completely destroy the structure; 7, mosaic structure ("Schuppen structur") like a bruised oolite structure; 8, alteration of hæmatite and limonite into magnetite in connection with cleavage; 9, marmorisation of limestones; 10, formation of confused kneaded structure ("Knet structur)"; 11, formation of new minerals, as garnet, staurolite, or mica in places of bruising. Such altered sediments are found in folded bands in the midst of true crystalline schists, and such mixtures are common at the ends of the central massifs, between two massifs, and even in the midst of them. They have here not only the same bedding, but other similarities also. The cleavage of one passes with very slight change into the other, the small folds are related, the stretching is in parallel directions, and the calcareous parts of the schists have their mica flakes arranged as in the neighbouring sedimentaries. From this we may conclude that the crystalline schists have suffered

as much deformation as the sedimentaries, but in their case we do not know the original form. These changes reach their maximum in the central massifs, of which Mont Blanc is one. At first sight, it seems as if the sedimentaries were always unconformable on the true crystalline schists, but in the case of the younger schists they are often parallel, and a great part of several of the central massifs is composed of Palæozoic strata, while in the southern massifs of the central Alps they are conformable throughout.

The changes here noted may be seen in all stages of completeness, but, in many places, it is impossible to say whether we are dealing with an original structure or with cleavage, and a new schistosity may be introduced at an angle with the old, when it is difficult to say which is the original one. The schistose structure is also sometimes very like fluidal structure. Lines of stretching are, however, always secondary, and sometimes the mica is frayed out, and at others pencil structure is produced. It is not certain that there are any rocks in the central massifs that show their original structure unaltered. In the midst of the Finsteraar Massif, Carboniferous rocks are foliated, as are also the Verrucano, and clay slates, granite becomes gneiss, and gneiss, by pressure, may resemble pounded granite, while mica schist may be so smashed as to resemble a clay slate. Belemnite-bearing Liassic rocks may also become garnet-[1] and staurolite-bearing.

The junction of these with the crystalline schists is much obscured by the mechanical deformation. He concludes that "the condition of the crystalline schists in the Alps is often altered by dynamo-metamorphism; original, and later, mechanically-induced structures are often scarcely distinguishable from each other." Even the positions are altered by inversion. From this it follows that "conclusions on the order of superposition ought not to be drawn from observations on these rocks in folded regions, but, for this purpose, we must study the outlying regions where Alpine inversions and deformations are absent."

447. Lory, Ch.—Sur la constitution et la structure des massifs de schistes crystallins des Alpes occidentales. [On the Constitution and Structure of the *Massifs* of Crystalline Schists in the Western Alps].

Compte Rendu Congrès Géologique International (1888), p. 86, with a Plate of Sections.

The stratiform crystalline schists he considers to be rightly called the "terrain primitif," if they have been formed under

[1] The mineral here referred to has since been shown by T. G. Bonney not to be garnet (though the author does not admit this, and adds zoisite).

different conditions to the ordinary sedimentary rocks. In the Alps they may be best seen in the zone of Mont Blanc and in the zone of Monte Rosa; on the south side of the latter they are often nearly horizontal, and the sedimentary rocks, as far as Jurassic, lie conformably upon them. The formation of the Alps as a mountain range must, therefore, have been subsequent to Jurassic times. Here the succession of the different groups of schists is as clear as the stages of the Jurassic rocks. At the top are the sericite schists, formerly called talc-schists, alternating with chlorite and hornblende schists, and together forming the "pietri verdi," under which title, however, some Trias beds have been included. Below these are the mica schist group, with cipolins, granular dolomites, and saccharoid marble. These become charged with felspar and change to gneisses. These in turn become less and less foliated and pass into granitoid gneiss, but below them all comes mica schist again. Chloritic gneiss, however, occurs amongst the pietri verdi, as that of Arolla, or its granitoid variety called arkesine. No Carboniferous rocks are known in this zone, they were therefore uncovered till the Trias, to which the lustrous schists (schistes lustrés) belong. The limestones and dolomites are granular and saccharoid, like the Carrara marble, which is also Triassic.

The limestones contain crystals of albite, and the lustrous schists contain crystals of quartz, mica, tourmaline, and garnet, lying parallel to the well-marked stratification, even when nearly horizontal. They are therefore independent of mechanical action, and were formed before the dislocations were brought about.[1] As similar crystals are formed in the underlying crystalline schists, they also have required no mechanical agencies for their formation. In his third zone, near Modane, the Carboniferous grits lie on these old schists, and contain fragments of them, already schistose, hence their schistosity is pre-Carboniferous in origin. In his second zone, near Courmayeur, the *schistes lustrés* contain conglomerates, with pebbles of *the* crystalline schists, Carboniferous grit, Triassic quartzites, and even of lower beds of the *schistes lustrés* themselves, hence the crystallisation in these latter must have been immediate. Elsewhere, higher zones up to the Eocene are conformable, and the mountain formation here must have been posterior to the last. In all these beds *fresh* crystals of albite, bipyramidal quartz, tourmaline and mica, are found, and in the Oxfordian marls of the Dauphiné orthoclase crystals occur. It is thus unnecessary to consider that similar crystals in the crystalline schists required "physical

[1] This is too brief a summary by the author of his results for us to expect the proofs to be given that these "*schistes lustrés*" are Triassic, and T. G. Bonney has expressed the opinion that they are Archæan.

conditions absolutely different from those of the Secondary and Tertiary periods." But he considers that the true crystalline schists were formed in a universal warm ocean, in which the production of minerals would be much more rapid and general.

In the zone of Mont Blanc the crystalline schists are more vertical and contorted, and this part of the Alps must, therefore, have been earlier formed into mountains. Here the schists were dislocated before the deposit of the unconformably overlying Carboniferous grits. Elsewhere the latter are conformable, but include conglomerates containing schist fragments. Another dislocation took place between the Carboniferous and Trias periods. Still later movements bent the Trias but broke the schists, so that there are no longer simple anticlinals and synclinals. In this zone also crystals have been developed in the upper part of the schists. When chloritic and felspathic they form peaks, and are called protogine. This zone is stratified, and in Mont Blanc forms a sharp synclinal. There is more of it in Mont Pelvoux, in anticlinals and synclinals, and limited by a great fault.

448. Lehmann, J.—Bemerkungen zu einigen Neueren Arbeiten über Krystallinisch-schiefrige Gesteine. [Remarks on some New Researches on the Crystalline Schistose Rocks.]

Compte Rendu Congrès Géologique International (1888), p. 104.

His conclusion as to the formation of parallel structure in the Saxon granulite by dynamo-metamorphism has not a general application; on the contrary, while many schists are of eruptive or plutonic origin, many others are derived from sedimentary rocks. Nor does he suppose that the whole secret of the granulite rocks themselves has been discovered. His conclusions, however, were arrived at before the appearance of Heim's work "Ueber den Mechanismus der Gebrigsbildung," though that author arrived at similar results. The statement by Roth that the bedded gabbro, which he calls zobtenite, is not an eruptive rock, rests on inadequate stratigraphical evidence. In the northern part of the granulite mountains that rock may often be seen passing into granular (korniger) granite. These granulites are not tuffs, and show no indurated bands, but are uniform in structure. The granite sometimes cuts across the granulite, and sometimes impregnates it. There are filled up veins in the bedded, as well as in the intrusive granite, which must have formed gradually during the splitting of the schists. He does not believe that the foldings of the rock have produced heat. The granitic boulders in the Obermittweida conglomerate have been called concretions, because the mica layers in them are continuous with

those beyond, but he shows that this is seldom the case, for they more often go round, and there are several kinds of pebbles, so that the coincidence is accidental. The rocks he has dealt with, though often micaceous, must not be confounded with true mica schists, or massive gneisses of whose origin we are ignorant. The former contain allothigenous elements of felspar, and they must, at best, be called only gneissose. The latter are practically granites with parallel structure, and we may look on them as non-eruptive granites, just as there may be eruptive and non-eruptive diorites and gabbros. Whether these true gneisses are produced by the hardening of the primitive crust, or by the melting of previous sediments, is a yet unsolved problem.

449. Lévy, M. A. Michel.—Sur l'origine des terrains crystallins primitifs. [On the Origin of the Primitive Crystalline Systems.]

Compte Rendu Congrès Géologique International (1888), p. 117.

(An extract from Bull. Soc. Geol. France, 3rd series, vol. xvi.)

The rocks called primitive are not always acid gneisses, but in some localities vast masses of other rocks form part of the same group. Thus in the Serrania de Ronda are whole mountains of dolomite, in the Alps are enormous masses of amphibolite; and in the Lyonnais the most abundant rocks are basic. On a large scale there is a certain uniform sequence, but they alternate with the earliest deposits of detrital origin, and in the midst of the Cambrian are rocks which a minute microscopical examination will scarcely permit us to distinguish from the most ancient gneisses. Moreover granites and granulites penetrate, bed by bed, into the gneisses and schists along their planes of schistosity. He accounts for the gneissose conglomerates by the engulphing of rounded pieces of the surrounding rocks by eruptive granites and granulites, which are always more felspathic than the enclosed fragments. These conglomerates cannot, therefore, be invoked as proving the detritic origin of such gneisses.

The composition of gneisses is very similar to that of eruptive rocks, but there are occasionally abnormal associations—as quartz, with hornblende or augite, and silicates of alumina, side by side with alkaline silicates. These are due to imperfect mixture of the magma. In the gneisses, the micas are interlaced and continuous, and have not the crystalline contours they present in granites. They are also of later origin than the fine felspar and quartz, while in granite they are of first consolidation. Whatever the origin of gneisses, the facts are irreconcileable with a previous

mixture of the magma, which is necessary to the hypothesis of their being produced in their present form. He then compares the gneisses with rocks, as seen in Brittany, which have suffered metamorphism and injection by masses of granite, and concludes that "the intimate structure of gneisses is identical with that of the sedimentary schists, modified by contact metamorphism, and then injected by eruptive rocks."[1] The bubbles in the quartz crystals are often wanting in the surface portions, but this does not show them not to be derivative, since the surface layer may be considered of secondary origin.

He then discusses the two hypotheses of the gneisses, &c., being the product of a conflict between the water and the molten crust, and of their being precipitates. The principal objection to the first seems to be the absence of any rocks that we can be certain are primitive; and to the second the difficulty of accounting for the regular and brief periodicity of the mica. He concludes that the gneisses are "the veritable primitive substratum of the earth's crust," but it has been many times remelted and injected by eruptive rocks, none of which latter are pre-Cambrian or surface rocks. He notes the reciprocal influence of the oldest sediments on the eruptive rocks.

450. Lawson, A. C.—The Archæan Geology of the Region North-West of Lake Superior.

Compte Rendu Congrès Géologique International (1888), p. 130.[2]

He divides the rocks of this region, the principally instructive parts of which are in the neighbourhood of Rainy Lake and the Lake of the Woods, into two divisions—the Upper Archæan and Lower Archæan. The Lower Archæan is the Laurentian, which he groups broadly as:—I. (*a*), Hornblende-syenite and hornblende-granite-gneiss, (*b*) Mica-syenite-gneiss and biotite-granite-gneiss, now in quartz; II., Biotite-granite-gneiss—very quartzose. This classification is not only petrographical but geological—the rocks classed together or divided in it occur associated or separated in the field. The foliation in these rocks graduates to zero. They have a granular structure (Rosenbusch's sense), the hornblendes have very frequently centres of augite, and the felspars are schillerised. They constantly contain plagioclase, but show feeble signs of pressure, certainly insufficient to

[1] This is said to be the result of the excursion of the French Geological Society into Brittany. Mr. E. Hill, however, came away from the same excursion with the conviction that true gneisses had not a common origin with the products of contact metamorphism.

[2] It seems quite a pity to have to make an abstract of this remarkable paper—not a word of which can be omitted without loss.

prove the foliation of the gneiss to be due to pressure acting on the rock after it had solidified.

The Upper Archæan consists of the Coutchiching and the Keewatin series. The former is a very stratiform series of mica schists and fine-grained gneisses. "The uniformity of the petrographical characters of the strata throughout the entire series is one of its most striking features. The thickness is between four and five miles, and quartz, garnet, and staurolite are abundant. The partings between the beds have often served as fissures for the deposition of vein quartz, proving the copious percolation of aqueous solutions. Hornblende is almost entirely absent. He considers these as undoubtedly metamorphosed sediments laid down in a period of extreme quiescence, and containing no limestones, quartzites, or volcanic intercalations. They differ entirely from the Laurentian rocks, their structure being "granulitic" rather than granular, *i.e.*, they are composed of small round grains.

The Keewatin series is also bedded. It is much more widely spread, and rests sometimes on the Coutchiching and sometimes on the Laurentian. The strata are mostly overlapping lenticular sheets with intercalated massive rocks. They are largely made up of altered volcanic rocks, and are more basic and less altered than the Coutchiching. They may be classed as:—I., Basic Volcanic; II., Acid Volcanic; III., Volcanic Clastic; IV., Detrital; V., Gabbro, Serpentine, and some Granite. No. I. is at the base, and varies in character according to the underlying series. No. II. following it shows a sequence of acid after rather basic extravasation in the same volcanic district.

These two series are stratigraphically conformable, but the very great difference in character between them represents a complete change of conditions. The pebbles in the basal conglomerates of the Keewatin are of such a character as would readily yield the Coutchiching schists as a result of metamorphism. Wherever the Laurentian rocks are observed in close juxtaposition with either the Coutchiching or Keewatin, blocks and angular fragments of the latter are found embedded in the Laurentian gneiss, most profusely near the contact, but also at great distances from it, up to a mile or more. The Laurentian was therefore plastic at a time when the others were hard and brittle. The main mass of the upper series is also more altered near the contact.

The history of these rocks has been, therefore, as follows: The Upper Archæan, being stratified, must necessarily have had a floor to rest upon; whatever the character of this might originally have been, it has entirely disappeared as a floor upon which the strata rest either conformably or uncon-

formably. The Laurentian nowhere affords evidence of having been the pre-existing basement, but it bears to the stratified rocks the relation of an irruptive mass. There is only one way of reconciling these statements. That portion of the earth's crust upon which the Upper Archæan was accumulating to a thickness of over nine miles must have been depressed, either by its weight or other causes, till it came within a zone of a sort of fusion compatible with the conditions at such depths, and not only was the Lower Archæan melted, but the lower parts of the Upper also. The Laurentian thus comes to act as a plutonic mass, while the bulk of the Upper Archæan was only metamorphosed by a molecular re-arrangement in the solid rock. He does not regard the fusion as a dry one, because of the liquid inclusions in the quartz-crystals, and the abundance of vein-quartz. The magma was not entirely homogeneous, but basic where part of the Keewatin has been melted into it, and acid where only the Coutchiching; it was tenacious, as the included fragments are torn asunder without the gneiss itself showing signs of pressure after consolidation, and the gneiss penetrates into the remotest crannies. The foliation is also probably due to its crystallising while in slow motion, or while tending to move.

It is noted as a confirmation of these explanations that the Lower Laurentian occurs in lenticular masses surrounded by the Upper like the holes in a net, and that the mineral veins in the Upper are not continued downwards into the Lower, where their distinctness must have been lost on fusion.

If these considerations are just, there is no reason why the circumstances should be confined to the Archæan period, and in fact, Dr. G. M. Dawson gives the same explanation of the Triassic schists and underlying gneissic granite in Vancouver, and Mr. E. R. Faribault of the similar Lower Cambrian rocks of Nova Scotia. He explains the stratified Laurentian of Ottawa, with its bands of limestone and quartzite, by supposing it "not impossible" that these bands may be practically inclusions, and the gneisses intercalated plutonic rocks.[1] His explanation, he says, "rules the Laurentian gneisses out of the category of metamorphic rocks, 'metamorphism' in the technical sense being understood to stop where fusion begins." He considers much of the regional metamorphism of the Upper Archæan to be "a widespread manifestation of what is known as 'contact metamorphism' and due to the same causes,"—part, however, is dynamical.

[1] Is it necessary that the same explanation should hold for all that has been called Laurentian? The gneisses themselves vary in character from one apparent bed to another, and can scarcely, therefore, be intercalations from the same plutonic magma.

451. Powell, J. W.—On the Crystalline Schists of the United States, and their Relations.

Compte Rendu Congrès Géologique International (1888), p. 153.

He gives a general *résumé* of results. 1. Part of the crystalline schists, or of rocks previously classed with them, is found to be fossiliferous, and belong to portions of the series from Cambrian to Cretaceous. 2. Another part, obviously clastic, is grouped in a system, for which the name Eparchæan is preferred, but they cannot be correlated from one part of the country to another. 3. The "Laurentian" and part of the so-called "Huronian" are Archæan, less obviously clastic, and separated from the Eparchæan by an unconformity. 4. Many of the massive crystalline rocks are eruptive, and of undetermined age. 5. Both clastic and eruptive rocks of various ages may become schistose. 6. The processes of metamorphism are diverse.

452. Irving, R. D.; Chamberlin, T. C.; and Van Hise, C. R.—The Crystalline Schists of the Lake Superior District.

Compte Rendu Congrès Géologique International (1888), p. 156.

This contains a general summary of conclusions, without the evidence, which has been previously published. Massive eruptive rocks have been rendered schistose. Ordinary fragmental rocks are cemented by infiltration, or by secondary growth of crystals round the fragments, or usually rendered schistose by metasomatic changes of felspar into mica or chlorite. No exceptional heat or pressure appears to be necessary for this. Rocks of organic and chemical origin, by the same process, become hæmatite, and others schists. The remaining schists may originate in some way of which we have at present no conception. After giving a brief account of the kind of schistosity in the Keweenawan, the Grand Cañon series, the Llano series of Texas, the true Huronian, the pre-Grand Cañon series, and the Laurentian, he says it is a "moot question whether there are any true crystalline schists of regional extent in the United States among the Cambrian and later geological formations."

453. Becker, G. F.—The Crystalline Schists of the Coast Ranges of California.

Compte Rendu Congrès Géologique International (1888), p. 170.

The older rocks of the Coast Ranges have mostly assumed a crystalline texture, and the different varieties are repeated again and again within limited districts. The crystalline rocks become schistose in scattered spots of no great size, and in no definite position in the series. There are many

differences between these and the Laurentian. In one portion of the range the schists are nearly all glaucophane rocks, with mica, quartz and felspar. Zoisite is intergrown, and coeval with the glaucophane, quartz, and felspar, and is thus an original constituent, as it is in the granular series. Both of these kinds of rock pass into ordinary sediments in the continuation of the same beds, though in the absence of zoisite "the resemblance to true eruptive diabases seems perfect." The schistose structure is along the original planes of bedding, and the age of the rocks in the unaltered parts is proved by fossils to be Neocomian. There are no eruptive rocks in the whole series, but the mass has been shivered to fragments, on an average smaller than a hen's egg. Where there is most disturbance there is most crystallisation, and only in the larger fragments can unaltered centres be found.[1]

454. Dutton, C. E.—The Crystalline Rocks of Northern California and Southern Oregon.

Compte Rendu Congrès Géologique International (1888), p. 176.

It is not known that any of these rocks are of Archæan age, the most crystalline containing lenticles with Carboniferous fossils. The more profoundly altered beds pass into, and alternate with, the less altered. There are also altered peridotites. With these, in the Coast Range, are rocks in which zoisite plays the part of both felspar and base. These and the porphyries are thrown into dire confusion.

***455. Lossen, K. A.—Einige Fragen zur Lösung des Problems der Krystallinischen Schiefer, nebst Beiträgen zu deren Beantwortung aus dem Paläozoicum. [Some Questions for Solution on the Problem of the Crystalline Schists, with Contributions towards the Answer in the case of the Palæozoic Rocks.]**

Compte Rendu Congres Géologique International (1888), p. 180.

He thinks the question can best be approached by studying the metamorphism of undoubtedly fossiliferous rocks and their associated tuffs. In the Harz there is no Archæan kernel, but the sedimentaries are pressed between masses of plutonic rock. The contact zones with granite and gabbro, etc., show the following authigenous minerals:—Quartz, Orthoclase, Albite, Plagioclase, Biotite, Muscovite, Hornblende, Actinolite, Augite, Bronzite, Chlorite, Epidote, Garnet,

[1] According to T. G. Bonney, "the evidence in support of the claim of 'crystalline schists' to be 'altered sedimentary strata of Mesozoic age,' has hitherto always broken down on careful examination." Will this be the case here?

Vesuvian, Tourmaline, Axinite, Wollastonite, Dichroite, Titanite, Spinel, Andalusite, Rutile, Magnetite, Hæmatite, Titaniferous iron ore, Pyrites, Pyrrhotine, &c., Calcite, Fluorspar, Apatite, and more rarely Anatase, Zoisite, Lithionite, Lepidolite, Corundum, Sillimanite, Kyanite, and Graphite. The porphyroids are metamorphosed porphyries and tuffs. He then propounds ten questions relative to the order of development of these minerals, and to the significance of structures usually regarded as characteristic of groups of eruptive rocks, as ophitic and micropegmatitic, &c., but comes to no certain conclusions in reply.

***456. Reusch, Hans.—A Summary of Results obtained from a Study of the Crystalline Schists in Western Norway.**

Compte Rendu Congrès Géologique International (1888), p. 192.

The rocks in this district are said to be Archæan, Cambro-Silurian, and Devonian. The first are chiefly granite and gneiss-granite, folded, cataclastic, and with epigenetic parallel structure. The second contain fossils and are phyllites, quartzites, and "gneisses," associated with schistose volcanic rocks, showing cores of granite and diorite, and peripheral tuffs and dykes. These are regionally metamorphosed by post-Silurian movements. "This is proved by the fact that fissility and a parallel banded structure which cannot be produced except by some powerful compression" are common. The trilobitic beds contain visible biotite. The quartz-eye-gneiss has sometimes a conglomeratic structure. The complex of gneiss and hornblende schist he interprets as due to the compression of "a dioritic rock interwoven with granite veins." The foliation of cross dykes is parallel to the general schistosity, and therefore oblique to the walls. The granite near Bömmalö is cataclastic, and has parallel structure, and along its southern boundary contains a rock resembling an altered conglomerate with fragments of amphibolite and calciferous schists. These he regards as "the remnants of beds which once occurred in the sediments by the fusion of which the granite itself has been formed."[1] He also shows some contorted Cambrian ? rocks below Silurian, which have been melted and injected into the latter.[2] The dioritic rocks are in like manner derived from tuffs and augitic lavas, but these conclusions he regards as hypothetical.

457. Various Authors.—Discussion on the Crystalline Schists.

Compte Rendu Congrès Géologique International (1888), p. 203.

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[1] Here we have cited an example of metamorphic granite.

[2] The diagram looks more like a dyke transgressing both.

J. R. Kilroe.—The schists near Killybegs show two sets of shearing in connection with a thrust plane. The primary foliation follows the bedding planes, but the secondary is oblique to it, is constant in direction, sometimes obliterates the primary, and is accompanied by the formation of new mica, but not by segregation.

Lory, Ch.—The crystalline schists of the Alps are sometimes discordant to, sometimes concordant with, the overlying rocks, but their characters were developed before the deposit of the latter, and are independent of the later dislocations, and he regards them as of primary origin.

Mattirolo, M. H.—The gneissic rock of Monts Chetif, and of La Saxe et Courmayeur is of Permian age, lying between fossiliferous Trias and Carboniferous; it is over 4,000 ft. in thickness and he adopts for it Giordano's name of *Besimandite*.

Macfarlane, T.—The crystalline schists form "part of the first solidified crust of the earth," the parallelism of the minerals is due to the motion of the mass, and their alteration to the primitive gases and fluids.

Issel, A.—The slopes of the Alps and Apennines round the Gulf of Genoa show talcose and chloritic schists of Ligurian (Eocene) age, and the limestones contain crystals of albite.

Heim, A.—The crystalline schists have suffered the same dislocations and mechanical changes as ordinary sedimentaries, and any order of succession must be sought in regions without crushing. The Central Alps is not one of these regions.

Hunt, T. S.—Fundamental granites and ancient gneisses are of aqueous origin.

Hicks, H.—Large areas of crystalline schists are invariably pre-Cambrian. Gneisses were igneous, mica and chloritic schists were volcanic ashes and muds. Newer metamorphosed rocks only partially simulate the crystalline schists.

Lapparent, A. de.—The "terrain primitif" has an independent existence, and its genesis is explained by a combination of chemical, mechanical, and calorific actions brought to their apogee [maximum ?].

Torell, O.—The ancient gneissose granite near Stockholm shows a globular structure which he considers to be gneissic breccia recemented by hydrothermal infusions.

McPherson, J.—Below the Cambrian rocks in Spain the crystalline schists are in three divisions of great thickness. At the base is granitoid gneiss, next micaceous gneisses, with limestones, amphibolites, pyroxenites, &c., and then mica schists, sericite, and chloritic schists passing into

argillaceous schists. They were formed during the first precipitation of water on the globe, when metamorphic action was at its maximum. Analogous rocks of later age are due to the energy set free by adaptations of the crust on shrinking.

Hull, E.—Structures due to mechanical force must not be confounded with those due to hydrothermal action, though the latter may be, but are not necessarily, produced by mechanical pressure indirectly.

Kinahan, G. H. — "Gneissosity" differs from "schistosity," and makes the rocks lose their individuality and become more or less of one type; it also changes schists into granitic gneiss, the bedding planes being obliterated. In some places hornblendic graduate into nodular or conglomeratic rocks, which may have been originally friction breccias. In the Lough Conn district granite gneiss is intrusive into schists, and is itself intruded into by diabase, and both have been subsequently affected by gneissosity, having the same direction as the main mass, but which has not affected the margins.

Gosselet, J.—In the Ardennes there are Devonian schists containing crystals of biotite, chloritoid, &c., while there is no eruptive rock to whose contact the metamorphism can be due. The rocks are more metamorphosed where less folded, and less where more folded; in the latter case, pressure has had visible mechanical effects, in the former, the energy has been converted into heat, which has enabled the water to produce new minerals.

Blake, J. F.—The rocks of Anglesey show that no clear distinction can be drawn between Archæan and later schists, the allothigenous fragments of the latter often disappearing entirely. Rocks may become crystalline without being orientated. Orientation must, in all cases, be due to a directed force. There are several varieties of it. The "quincuncial" is due to the orientation of the scattered mica, "laminar" to the alternation of irregular grains of felspar and quartz, &c. These varieties show no sign of movement in the elements; "elemental" is due to the elongation of the individual elements, indicating molecular movement; "mylonitic lines" are lines of separation of lenticular bands due to the movement of one part of the rock over the other. Schistosity proper is a phenomenon of statical pressure; the false schistosity of mylonites is a kinetic phenomenon, and may be superimposed on the true.

Claypole, E. W., doubted if the tree trunk and the Belemnites said to be found in gneissose rocks in the Alps were rightly identified.

Renevier, E., replied that the vegetable nature of the

tree trunks was universally admitted by the Swiss geologists, and fossils had been found in other countries in crystalline schists. All such schists could not be pre-Cambrian, as in the Alps they passed into Coal-measures.

Hunt, T. S., had not said that all schists are pre-Cambrian, but the causes which produced them were continually decreasing in intensity. Nevertheless, there were Carboniferous schists in North America.

Heim, A., said the Swiss fossils did not occur in true gneisses, nor in protogine, but in intercalated zones of less completely crystallised schists.

Delgado, J. F. N., showed graptolites preserved in chiastolised slate.

Lapparent, A. de, said trilobites are found in chiastolite slate in Brittany. Pressure can only produce heat when the motion is differential, and its results must thus be limited. Metamorphism, however, is not limited.

Lapworth, C., as a follower of Lyell, Hutton, and Darwin, expects a demonstration of the existence of many Archæan systems only locally altered.

Callaway, C.—1. Igneous rocks may become schistose by pressure. Greater pressure may produce recrystallisation in a granular form, or felsite may be converted into mica and quartz. 3. Rocks or minerals may be injected into others. When granite is injected into diorite, and changes the hornblende to black mica, and the plagioclase to white mica, the final result in some cases is a mica schist, in others, a gneissic quartzite. The injected minerals are chlorite and ferric oxide, which pass along shear planes in the granite and form chlorite-gneiss and part of the chlorite becomes black mica. 4. Dynamo-metamorphism may change slate to schist, when the foliæ are either parallel to the stratification or to the cleavage.[1]

458. Fisher, O.—On Dynamo-Metamorphism.

Geol. Mag., n.s., Dec. 3, vol. viii., p. 47.

Continues the discussion of last year [see Nos. **575, 576**, 1890]. A chemical friend states that "as the molecule includes the atoms" "chemical energy" is certainly molecular, and as a proof that chemical action need not generate heat, instances the formation of CO and NO with loss of heat.

459. Harker, A.—Dynamo-Metamorphism.

Geol Mag., n.s., Dec. 3, vol. viii., p. 48.

Another contribution to the same discussion. In Spring's experiment of the union of copper and sulphur under pressure "so much of the mechanically-developed energy as takes the

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[1] This discussion shows how various are still the opinions on the age and origin of "crystalline schists."

form of heat is carefully removed," and hence "the energy absorbed in the combination comes directly from the mechanical work done, without the intervention of heat."

*460. **MacMahon, C. A.—Dynamo-Metamorphism.**

Geol. Mag., n.s., Dec. 3, vol. viii., p. 89.

Replies to Mr. Harker above, that Spring himself does not attribute his results to pressure directly—but to contact brought about by pressure—which is shown by the necessity of operating in vacuo, lest the air should intervene;—he also postulates a certain degree of heat.

*461. **Irving, A.—On Dynamic Metamorphism.**

Geol. Mag., n.s., Dec. 3, vol. viii., pp. 94 and 296.

Replies to the above. He points out that if x be the heat required to separate the atoms of the original molecules, y the heat evolved in the recombination of the atoms to form new molecules, and θ the total amount of heat evolved or absorbed in the whole operation, then

$$\theta = y - x$$

and will be positive or negative according as y is greater or less than x. To cite examples in which θ is negative is not to the point. His statement that "chemical combination must generate heat" means that y is always positive. The real question, therefore, is "does pressure promote the dissociation of previously stable molecules, so as to render the intra-molecular energy of their atoms available for entry into new combinations?"[1] He next shows that when work is done upon rocks, energy is used up on one side, but not necessarily stored on the other. In the case of Spring's experiment, the molecular volume of the compound is less than the sum of the volumes of the two elements, thus pressure aids the result when this involves an increase of density; but in another experiment by the same worker, a double acetate of copper and lime is broken up by pressure into the two simple acetates for the same reason, viz., that the resulting products occupy less space. He considers that the heat produced by molecular friction during compression would be of too low an intensity to be of any practical importance, and the real *rôle* of pressure in bringing about mineral change, is rendering possible the existence of superheated water, as in the case of the artificial production of quartz and hornblende.

462. **Fisher, O.—On Dynamo-Metamorphism.**

463. **Harker, A.—Dynamo-Metamorphism again.**

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[1] *i.e.*, does it supply part of x? It will be observed that the term "intra-molecular energy," about which there can be no doubt, is now adopted.

464. Irving, A. — Dynamo - Metamorphism "again."

Geol. Mag., n.s., Dec. 3, vol. viii., pp. 430, 431, 479.

These are merely letters correcting personal misunderstandings.

***465. Blake, J. F.—The Effects of Pressure on Rock Structure.**

Abstract Proc. Western Microscopical Club, p. 6.

A short *résumé* of the well-known phenomena of rocks under strain, in the formation of orientation, strain shadows, mylonitic lines and foliation-cleavage, &c. It is also pointed out that the apices of the cones in cone-in-cone structure always point towards the hard substance which it adjoins, indicating their production by pressure *towards* that substance or obstacle.

***466. Fox, Howard.—On the Micaceous Schists of the Penolver District (the Lizard).**

Trans. Roy. Geol. Soc. Cornwall, vol. xi., p. 327.

Penolver is ¾ mile E.N.E. of the mica schist of Polpeor. Here in the cove of Polledan and neighbourhood are numerous bands of mica schist (inserted on a map as a . . . m) interstratified conformably with hornblende schist. One of the hornblende schists is porphyritic. Four specimens are described by **J. J. H. Teall,** viz., a garnetiferous mica schist, a granulitic rock, an epidotic rock, and a porphyritic (felspar) hornblende schist.

***467. Kilroe, J. R.—Explanatory Memoir to accompany the Maps of South-West Donegal, Sheets 22, &c. Chap. III. Metamorphism of the Region.**

Mem. Geol. Surv. Ireland.

The effects of mechanical pressure are illustrated by a remarkable diagram of a section on the side of Slieve League tourist path, showing two bands of quartzite obliquely divided by "thrust planes" and the pieces displaced, the intervening siliceous schists being quite continuous, and the interspaces filled with mica schist. Another quartzite at Cappagh has horizontal "shearing planes" across nearly vertical beds. The surfaces are in many places striated on both sides in a constant direction, N. 20° W., which is the same as the direction of motion of the separated pieces of quartzite—presuming them to have once formed a single mass. The movement thus indicated produced schistosity. The harder beds have crumpled while the softer have yielded.

On the shore of Teelin Harbour "limestone has at one point invaded a massive band of quartzite and forced the different portions of it apart, precisely as if the former had been *intruded* in a plastic or molten condition" [fig. 114].

This is explained by the limestone having been squeezed in. The schists on the south flank of Binbane and Carnaween show movement from the east, the sharper ends of the pieces of vein quartz, which have been moulded by the motion, pointing west, yet the quartzite crowning Carnaween has moved S.E. along a series of thrust planes—showing a complex movement.

A schist near Maas shows a tendency to break into rods, which he accounts for by a "horizontal movement *en masse* productive of vertical schistosity" combined with a differential movement of the rock particles. North of Cleengort Hill are seen large round masses of garnet rock, with idocrase and quartz, apparently embedded in schists, but believed to be protuberances of a hidden bed of limestone; round these the foliation of the schists "suggests a distinct *flow* of the rock from the eastward, the folia conforming to the outline of the spheroidal obstructions." In Lettermacaward a band of quartzite has been broken, and schist from one side squeezed through to the other with its folia parallel to its path. Other examples are given of the drawing-out of limestones, and the production of a "mylonite" from quartzite. Thus the apparent dips and bedding are in certain cases due to shearing. Some zones, however, as near Loch Anna, have escaped the later shearing movements, zigzag lines of foliation crossing them at right angles to the foliation above and below.

A sketch on Claddagh Hill is given, showing felstone passing by an irregular and obscure boundary into mica-schist, into which it is supposed "to have been partly converted by metamorphism." East of Killybegs harbour a second structure has been superinduced by a westward movement of the upper portions of rock over the lower. The shear zones thus produced give an appearance of unconformity when on the surface, but are seen to be repeated in the midst of the mass. These facts induce the author to conclude that there have been two periods of dynamic metamorphism. Even where only one is apparent, it may be because it has entirely obliterated the former, and he gives a sketch in Cappagh [fig. 113] where quartz pebbles have been drawn out into lenticles in one direction, representing the only relics of the first shearing, and then the whole has been foliated in a nearly perpendicular direction.[1] Between the two periods the granite was intruded. The geological history of the region is, therefore, divisible into

[1] If this is a true account of the phenomenon, and if the quartzite lenticles are themselves foliated horizontally, then we have here an instance of foliation without differential movement, unless indeed the *slope* of the quartzite lenticles results from such movements.

five stages:—(1) deposit of the sediments, (2) intrusion of basic rocks in part, (3) first shearing, (4) intrusion of granite, (5) second shearing. Even the quartz veins of an earlier period have been broken up and dragged along by the second shearing.

That the granite intrusion took place between the two periods of shearing is shown, first, by the fact that the foliation of the granite is remarkably parallel to the foliation of the surrounding schists, even when this curves round, and secondly, that pieces of schist enclosed in the granite have a foliation independent of the surrounding rock.

468. Teall, J. J. H., and Hyland, J. S.—Appendix to Explanatory Memoir to accompany Sheets 31, &c.

Geol. Survey of Ireland. [*See* No. **72.**]

The former author describes 29 samples of the Archæan rocks east of Ballyshannon, and one of the later schists. They include—Muscovite-biotite-gneiss (8), Biotite granite (1), Muscovite gneiss (2). Biotite gneiss (4), Granulitic gneiss (2), Biotite schist (2), Epidiorite (4), Felspathic Eclogite (2), Hornblende-biotite schist (2), Hornblende schist (1), Garnetiferous amphibolite (1). Details of the component minerals and their association are given. The latter author describes the olivine-basalts and olivine-dolerites, which are ophitic, and the olivine is decomposed to a substance like hullite. There is very little interstitial matter, but there are spherical patches, which were originally vesicles, now partially filled with the matrix or chalcedony and carbonates. The occurrence of the dolerites is detailed in the Memoir, Chapter VI.

SEDIMENTARY ROCKS.

***469. Hutchings, W. M.—Further Notes on Fireclays, &c.**

Geol. Mag., Dec. 3, vol. viii., p. 164.

These clays were formerly studied by means of thin sections [see No. **590,** 1890], but he has now adopted the method of levigation, by which he separates the material into that which falls after 90, 15, and 2 minutes respectively, the first of which makes up a large part of the whole. The finest portion contains "far away the largest portion of the rutile needles of the clay—these are exceedingly abundant."[1]

[1] We should naturally expect, then, that the titanic acid of the rutile would be clearly shown on analysis. Such analysis, showing a corresponding amount of titanic acid in proportion to the abundance of the needles, is necessary to carry conviction that these needles *are* rutile in every case—it has at most as yet only been proved in one or two.

The main portion consists of very minute flakes, which are said to be "micaceous." These form a leading component of the original clay. These two minerals are here quite separate. There is "a good deal of matter too minute for identification," but he "cannot make out anything that could be safely referred to kaolin."[1]

In the middle-sized material the flakes below a certain pretty definite size contain rutile needles, but those above it do not;—this size is $\frac{1}{1000}$-in. Beyond a lower limit the flakes no longer *contain* rutile. The reason of this is that the larger flakes are compound, and the needles lie between the flakelets, being set free when they separate. In the coarser grades there is a good deal of original, non-rutiliferous muscovite and biotite. The question is whether these "rutile" needles and "micaceous" flakes are original or secondary. If the rutile was originally contained in the clastic mica, why, he asks, is there a limit of size? since the smaller flakes *must* have been derived from the larger,[2] and he raises the same objection to their being due to the weathering of biotite. No explanation, however, is given of the upward limit, on the hypothesis of the authigenous development.

***470. MacMahon, C. A.—Note on the alleged Genesis of Rutiles in Fireclay.**

Geol. Mag., Dec. 3, vol. viii., p. 259.

This is a discussion of W. M. Hutchings' paper [No. **469**]. He thinks that the promiscuous orientation of the flakelets composing the compound flakes would be prevented by the polarity of the first formed mica molecules, and that they are more akin to mechanically mixed agglomerates, as the material sank in the water. He suggests that in the process of abrading of the clay for observation the rutile needles already present may have been rubbed off the larger flakes, while the smaller ones escaped. Even if secondary, the rutile needles may have crystallised out of the titanic acid which has got between the flakelets by capillary action; or they may have come from the micaceous ilmenite. In any case, they may have been formed in the mud by ordinary aqueous action, the rutiliferous mica having come from one source, and the non-rutiliferous from another.

***471. Hutchings, W. M.—Rutile in Fireclays. Reply to General MacMahon.**

Geol. Mag., Dec. 3, vol. viii., p. 304.

He denies that his treatment of the clay could have separated the needles from the larger flakes, and points out

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[1] In what sense does the author use the word kaolin? and how does he recognise it?

[2] This does not appear to be necessary; the rutiliferous mica might have come from a distinct source.

that in the production of mica from felspar, or felspathic ash, the flakes are actually promiscuously orientated, and that the micaceous ilmenite is itself secondary. He then asks the question, if these needles are not formed *in situ*, what is the rock in which they are can be found in sufficient quantity as an original constituent?[1]

472. Hutchings, W. M.—Notes on the Altered Coniston Flags at Shap.

Geol. Mag., Dec. 3, vol. viii, p. [illegible].

In Wasdale Beck, above the falls, there is seen developed in these flags, before the development of spots, and in more quartzose beds than usual, some new hornblende allied to tremolite; and at another locality in the same beck, where the spots are commencing, some colourless garnets. Neither of these products of alteration were observed by Harker and Marr (No. **413**). He has been unable to determine the minerals that are crystallising in the spots. Some are mica, others may be andalusite, but others, again, are neither of these. He has not been able to satisfy himself as to the production of new felspar in any of these sedimentaries. At the falls, where the metamorphism has commenced to form brown mica, and to regenerate the quartz, abundant "clay-slate needles" are seen. These he calls "original," i.e., prior to the actual metamorphism. On further change they disappear, and rounded and ovoid grains of rutile appear in the limpid mosaic within the quartz crystals; at a later stage, these rutiles form clusters. In some of the spots he has found clusters of minute [illegible] in. long crystals of anatase. Sphene and ilmenite are also observed where the "original rutile" has disappeared.

473. Hunt, A. R.—On the Occurrence of Detrital Tourmaline in a Quartz Schist West of Start Point, South Devon.

Geol. Mag., Dec. 3, vol. viii, p. 465. Abstract of paper read at the British Association, Aug., 1891.

A Devonian sandstone from the N.E. end of Slapton sands contains detrital tourmaline and white mica. So does a quartz-schist amongst the mica-schists west of Start Point. Quartz of fine grain and iron are common to the two. "It seems difficult to avoid the conclusion that such similar rocks must be of like age." He cannot think where the tourmalines can have come from, if there are no pre-Devonian schorlaceous granites in the neighbourhood.[2]

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[1] Roth states that "separation of the titanic acid of *[illegible]* micas as rutile is often enough observed."

[2] Compare the views of **W. A. E. Ussher**, No. **88**, who, like the author, regards the Dartmoor granite as pre-Devonian.

***474. Hunt, A. R.—On the Origin of the Saline Inclusions in the Crystalline Rocks of Dartmoor.**

Rep. Brit. Assoc. for 1890, p. 815.

Twenty-four sections of rocks of the Dartmoor granite, of the finer grained vein granite in the same and adjacent rocks, of the "quartz-tourmaline-felspar veins of aqueous origin," and of the veins of pure quartz in the Culm shales have been examined microscopically, and every one contains fluid inclusions often enclosing cubic crystals. These crystals, from their similarity of shape to those in the Cornish granites, he assumes to be those of salt. The bubbles in a certain quartz crystal vary in size and activity, a circumstance in this case inexplicable on the hypothesis of original and secondary inclusions, or by the variation in the weight of superincumbent strata. "After consolidation this crystal, at least, was never crushed, nor was it plastic, nor permeated by fluids" [*cf.* No. **581,** 1890] "but during growth it was subject to rapid alternations of salt water and fresh and to great changes of pressure," due to the irregular heating of the water. The following is his hypothesis to account for the salt and bubbles of various size. If brine came in contact with reheated granite, the heat would vaporise the brine, and make a fresh-water inclusion side by side with a brine inclusion previously formed at a lower temperature.[1] He then says that the granite has been cracked throughout, and the salt has probably been included in it by a similar process.

***475. Sollas, W. J., and Cole, G. A. J.—The Origin of certain Marbles—A Suggestion.**

Scient. Proc. Roy. Dublin Soc., vol. vii., n.s., pt. ii., p. 124.

They have noticed in a coral-sand rock from the Torres Straits an intermixture of rounded olivine and other grains, such as was described by W. L. Green in the Hawaiian Islands, and they are reminded of the structure of the Tiree marble, which likewise consists of green grains of pyroxene in a flesh-coloured matrix of altered limestone. They suggest therefore that this latter may have been originally a wind-blown coral sand, and even refer to Eozoon in this connection.[2]

***476. Carus-Wilson, C.—Syllabus of a Lecture on Sands and Sandstones, with Special Reference to Musical Sands.**

Pamphlet. Oxford: 8vo, Alden & Co.

Introduces the term Psammology for the study of sands. The nature of musical sands is not here explained.

[1] How is it known that any of the inclusions are of "fresh-water"?

[2] The characters and mode of occurrence of Eozoon cannot be explained in this way.

ECONOMICS.

MINERALS.

477. Mineral Statistics of the United Kingdom for 1890.

London: H.M. Stationery Office, 8vo. Price 1s. 4d.

The numbers are given in tons.

Alum Clay.—Ulster, 11,527.

Aluminium.—Northumberland and Worcestershire.

Alum Shale.—Yorkshire, 6,420.

Antimony.—Dumfriesshire, 7.

Arsenic.—Cornwall, 3,143; Devonshire, 4,133.

Arsenical Pyrites.—Cornwall, 1,536; Devonshire, 3,578.

Barytes.—Cumberland, 170; Derbyshire, 992; Devonshire, 2,000; Durham, 185; Flintshire, 62; Montgomeryshire, 1,061; Northumberland (Carbonate), 5,679; Shropshire, 7,170; Westmoreland, 396; Yorkshire (N. Riding), 368; Yorkshire (W. Riding), 1,204; Connaught and Munster, 6,066.

Bog Ore.—Dublin, 5,897; Londonderry, 4,448; Donegal, 410; Mayo, 3,757.

Fireclay, China Clay, &c.—Bedfordshire, 99; Buckinghamshire, 120; Caermarthenshire, 12,361; Cheshire, 6,409; Cornwall, 393,509; Cumberland, 50,262; Denbighshire, 120,818; Derbyshire, 34,150; Devonshire, 89,569; Dorsetshire, 92,374; Durham, 427,716; Flintshire, 125,084; Glamorganshire, 144,767; Gloucestershire, 5,858; Lancashire, 116,957; Leicestershire, 54,907; Monmouthshire, 103,490; Northumberland, 195,937; Shropshire, 20,837; Somersetshire, 6,605; Staffordshire, 211,750; Surrey, 8,054; Warwickshire, 35,299; Worcestershire, 97,540; Yorkshire, 227,248.

Argyle and Dumfries, 115; Ayrshire, 87,175; Clackmannan, 4,104; Dumbartonshire, 28,141; Edinburghshire, 52,064; Fifeshire, 23,618; Haddingtonshire, 11,557; Lanarkshire, 294,925; Linlithgowshire, 14,126; Renfrewshire, 37,591; Stirlingshire, 54,449.

Ulster, 3,910.

Other Clays.—Devonshire (Black), 200, (Carbonaceous), 370; Monmouthshire (Red Marl), 625; Shropshire (Red Clay), 46,875.

Fullers' Earth.—Somersetshire,——; Surrey, 4,000.

Coal.—Brecon, 259,260; Caermarthenshire, 762,032; Cheshire, 677,656; Cumberland, 1,740,413; Denbighshire, 2,221,497; Derbyshire, 10,455,974; Durham, 30,265,241; Flintshire, 754,149; Glamorganshire, 21,426,415; Gloucester-

shire, 1,419,616; Lancashire, 22,123,522; Leicestershire, 1,455,910; Monmouthshire, 6,895,410; Northumberland, 9,446,035; Nottinghamshire, 6,861,976; Pembrokeshire, 71,908; Shropshire, 693,146; Somersetshire, 921,870; Staffordshire, N., 4,892,561; Staffordshire, S., 8,881,068; Warwickshire, 1,744,174; Westmoreland, 1,182; Worcestershire, 923,531; Yorkshire, 22,338,886.

Argyle, 106,128; Ayrshire, 3,159,727; Clackmannan, 402,733; Dumbarton, 339,559; Edinburgh, 868,878; Fife, 3,121,646; Haddington, 300,159; Kinross, &c., 55,908; Lanark, 13,584,770; Linlithgow, 782,645; Renfrew, 58,351; Stirling, 1,498,085.

Connaught, 9,781; Leinster, 78,609; Munster, 5,440; Ulster, 8,437.

Total, 181,614,288.

Cobalt and Nickel Ore.—Flintshire, 84.

Copper Ore.—Anglesey, 118; Cardiganshire, 33; Carnarvonshire, 600; Cornwall, 5,271; Devonshire, 6,038; Isle of Man, 6.

Ireland, 70.

Copper Precipitate.—Anglesey, 331; Cornwall, 2.

Ireland, 12.

Fluor Spar.—Derbyshire, 258; Durham, 10.

Gold Ore.—Merionethshire, 575 (206 ozs.).

Gypsum.—Cumberland, 20,854; Derby and Notts, 91,065; Staffordshire, 20,583; Sussex, 3,947; Westmoreland, 3,844.

Iron Ore.—Brecon, 87; Carmarthenshire, 138; Cumberland, 1,431,159; Denbighshire, 474; Derbyshire, 23,732; Devonshire, 4,155; Durham, 11,488; Flint and Glamorganshire, 30,786; Gloucestershire, 65,611; Lancashire, 968,467; Leicestershire, 609,964; Lincolnshire, 1,052,409; Monmouthshire, 18,930; Northamptonshire, 1,278,381; Nottinghamshire, 614; Oxfordshire, Rutland and Wiltshire, 143,339; Shropshire, 47,059; Somersetshire, 636; Staffordshire, 1,224,510; Warwickshire, 2,155; Worcestershire, 12,228; Yorkshire, 5,695,006.

Ayrshire, 446,246; Dumbartonshire, 107,767; Edinburghshire, 28,729; Fifeshire, 4,100; Kinross, Perth, and Sutherland, 21,487; Lanarkshire, 113,501; Linlithgowshire, 76,161; Renfrewshire, 162,561; Stirlingshire, 38,283.

Ulster, 1,336+159,268.

Iron Pyrites.—Anglesey, 30; Carnarvonshire, 5,200; Derbyshire, 1,270; Lancashire, 22; N. Staffordshire, 10; Nottinghamshire, 128; Shropshire, 283; S. Staffordshire, 588; Warwickshire, 2,280; Yorkshire, 14.

Dumbartonshire, 73.

Wicklow, 6,120.

Jet.—Yorkshire, 1,228 lbs. (Kettleness to Hinderwell).

Lead Ore.—Brecon, 389; Cardiganshire, 1,666; Carmarthenshire, 519; Carnarvonshire, 1,116; Cumberland, 2,272; Denbighshire, 1,416; Derbyshire, 4,026; Devonshire, 182; Durham, 9,781; Flintshire, 5,222; Montgomeryshire, 617; Northumberland, 3,195; Pembrokeshire, 10; Shropshire, 2,101; Westmoreland, 1,419; Yorkshire, 1,683; Isle of Man, 6,141.

Lanarkshire, 2,026; Dumfriesshire, 1,863.

Wicklow, 7.

Manganese Ore.—Carnarvonshire, 53; Cornwall, 83; Derbyshire, 67; Devonshire, 193; Merionethshire, 12,018; Somersetshire, 30.

Ochre and Umber.—Anglesey, 3,156; Cumberland, 35; Derbyshire, 97; Devonshire, 3,352; Glamorganshire, 407; Gloucestershire, 10; Lancashire, 220; Somersetshire, 11,088 + 10,816.

Wicklow, 603.

Oil Shale.—Cumberland, 7,608; Dorsetshire, 150; Flintshire, 3,438; Northumberland, 90; Staffordshire, 13,130; Yorkshire, 7,351.

Ayrshire, 25,659; Edinburghshire, 734,659; Fifeshire, 144,497; Lanarkshire, 55,355; Linlithgowshire, 1,218,506; Stirlingshire, 1,807.

Petroleum:—Derbyshire, 35.

Phosphate of Lime.—Bedfordshire, Cambridgeshire, Suffolk, 18,000.

Salt.—Cheshire (Rock), 159,088, (Brine), 1,440,088; Durham (Brine), 199,971; Lancashire (Brine), 7,877; Staffordshire (Brine), 7,135; Worcestershire (Brine), 267,348; Yorkshire, 35,700.

Antrim (Rock), 29,642.

Silver from Lead ores, 291,724 ozs.

Slates.—Brecon, 90; Cardiganshire, 46; Carnarvonshire (with Denbigh), 267,578; Cornwall, 12,047; Cumberland, 2,978; Denbighshire, 1,335; Devonshire, 520; Merionethshire, 146,718; Montgomeryshire, 1,412; Westmoreland, 1,528.

Stone.—The amount from mines is small compared with openworks giving no return.

Strontia.—Gloucestershire, 10,276.

Tin Ore.—Cornwall, 14,867; Devonshire, 43.

Uranium Ore.—Cornwall, 22 (value £2,200).

Wolfram.—Cornwall, 104 (value £1,848).

Zinc Ore.—Anglesey, 280; Cardiganshire, 3,734; Carnarvonshire, 169. Cumberland, 4,869; Denbighshire, 6,593; Derbyshire, 150; Flintshire, 1,117; Merionethshire, 125; Montgomeryshire, 321; Shropshire, 246; Isle of Man, 4,388.

Dumfriesshire, 49.

478. Collins, J. H.—A Practical Dictionary of English and Foreign Mining, Metallurgical, and Mineralogical Terms. Addenda.

"Colliery Guardian," vol. xxi., pp. 28, 118, 162, 250, 294, 334, 379, 418.

478a. Davies, J.—The Diamond.

Journ. Liverpool Geol. Assoc., vol. xi., p. 45.

Gives a general account of the characters, and localities of this mineral, with the uses of the several kinds.

***479. Goodchild, J. G.; Clough, C. T.; Dakyns, J. R.; De Rance, C. E.; Barrow, G.—The Geology of the Country around Mallerstang.**

Mem. Geol. Surv., chaps. xiii., xiv.

The principal metal here obtained is lead, in the form of galena. It occurs in the faults and in "flots" or veins which run from the faults between the strata. The galena is very poor in silver. The veins are principally connected with the calcareous and cherty beds; the sandstone veins are irregular in yield, and those in shale are always poor. The principal ore-bearing beds are in the upper part of the Great Scar Limestone, ranging up through Yoredales to Millstone Grit, with the Main Limestone as the centre. They are mostly confined to the south-eastern corner of the map. The ore is sought for by a system of "Hushing" or making a dam, and flooding from it along a certain line, so as to lay bare the rocks; the gravel thus brought down also repays working for its "flood-ore." The accompanying minerals are principally calcite and barytes—the former in nail head crystals, cerussite, iron pyrites, zinc blende, and occasionally quartz and dull-coloured fluor spar occur. Copper pyrites is found in veins in the district outside the lead-bearing area, as at Clouds, near the Dent fault. Iron occurs in clay ironstone nodules in the calcareous portion of the shales, and hæmatite near the present outcrop of the red rocks of the Eden Valley. It is most abundant in the calcareous rocks, where it occurs in pockets. It must have been formed by substitution for the carbonate of lime, because the stratification passes through it, the chert nodules remain in it unaltered, and traces of various fossils may be seen in it, while it actually passes in hand specimens into limestone.

Details are given of the mines in Wensleydale; also in Swaledale, where the principal vein is called the Stockdale vein, which runs along an east and west fault along Swaledale and Arkendale. The faults in this district have a habit of breaking their course and running for some distance along the line of a cross-vein. The seams of coal that can be at all worked occur at various horizons, viz., just below the Middle Limestone—the Moor Cock seam; below the

Underset, only workable towards the west: at the base of the Main Limestone: associated with the Little Limestone, becoming more important to the north: in the Ten-fathom Grit, the largest seam, 0—30 inches, called the Tanhill: it lies near the base of the Millstone Grit under Mallerstang Edge and elsewhere. The Carboniferous sandstones yield building stones and "slate," and Permian breccias near Kirkby Stephen are extensively used.

*480. **Postlethwaite, J.—The Deposits of Metallic and other Minerals surrounding the Skiddaw Granite.**

Trans. Cumberland and Westmoreland Assoc., vol. xv., p. 75, with a map.

A general sketch of the geological features of the district is given.[1] The mineral veins of Caldbeck run parallel to the igneous rocks and at a lower level, and it is suggested that their contents are derived partly from water passing over the latter and partly from decomposing sulphides already deposited. The Blencathra veins on the S.E. run towards the centre of the mass, and the veins in the south and west are very unproductive, though corresponding in position respectively to the above.

480a. Stephens, F. J.—Mining in the Mendip Hills.

59th Annual Rep. Roy. Cornwall Pol. Soc., p. 108.

A general account of that district.

481. Nolan, J., and Others.—Explanatory Memoir to accompany Sheets 3, &c.

Mem. Geol. Survey Ireland, chap. xiv. [*See* No. **71**.]

The following minerals of value are recorded from N.W. Donegal:—Silver Lead Ore, Bog Iron Ore, Molybdenite, Steatite, Serpentine, Alunite, Sulphur Ore, Pyrophyllite, Wad, Slates, Brick Clay, Honestones, Flags. The Limestones, Sandstones, Granite, Whinstone, and Lamprophyres are quarried for use.

482. Brierley, J.—Hampshire Fullers' Earth in its Chemical Aspects.

Papers and Proc. Hampshire Field Club, vol. ii., p. 84.

Gives an analysis of Fullers' Earth from 200 feet below Greyshott Down, and compares it with other analyses of Fullers' Earth.

Water, &c.	18·80
$Si\,O_2$	45·56
$Al_2\,O_3$	18·10
$Fe_2\,O_3$	9·31
$Ca\,O$	5·44
$Mg\,O$	6·21

[1] The "hornblende picrite" of Little Knot is said to be made mostly of hornblende, and olivine is not even mentioned!

483. M. E.—The Forests of Dean Ore Mines. The Iron Ore Mines at Skake Mantle.

"Colliery Guardian," vol. lxii., p. 762.

The iron ore is hæmatite in the Carboniferous Limestone in the following section:—

Whitehead limestone	30 ft.
Reddish limestone	16 ft.
The limestone with brown hæmatites	40 ft.
Grey limestone with some ore	36 ft.
Red limestone	298 ft.
Black rock limestone	60 ft.

These dip from 45° upwards to N.W.

COAL.

***484. Holgate, B.—Some Physical Properties of Coal.**

Proc. Yorkshire Geol. and Polyt. Soc., vol. xi., pt. iii., p. 460; and Rep. Brit. Assoc. for 1890, p. 796.

A general discussion of the various kinds of coal, particularly those of Yorkshire, and an attempt at the explanation of the causes of their characters, particularly that of their cleavage and the resulting natural sizes of their pieces, the principal cause being pressure. The smaller pieces make the best coke, the larger are most useful for furnaces working at a high temperature. The principal difference between a caking and a non-caking coal is that the former has the cleat close together, so that it breaks down in the fire, and prevents a free passage of air; and as the sulphide of iron and other fusible salts lie in between the cleats they fuse with the ash and choke the furnace.

485. Durant.—Coal and its Products.

Rep. Marlborough Coll. Nat. Hist. Soc., No. 39, p. 64.

A general account of coal beds and their fossils, the varieties of coal and their uses.

***486. Garforth, W. E.—Deep Mining.**

Proc. Yorkshire Geol. and Polyt. Soc., vol. xi., pt. iii., p. 469.

The difficulties of deep mining for coal relate to the natural heat, and to the weight of the superincumbent strata. None of these things are prohibitive of getting coal, and as the deeper seams are some of the best, the author believes that coal will always be followed as deep as it exists. The deepest mine at present is the Ashton Moss, which has a shaft of 2,850 ft., and the incline from its base leads down to 3,086 ft. from the surface.

487. Miller, R.—On the Coal-field adjoining Barnsley.

Proc. Midland Inst. of Min., Civil, and Mec. Engineers, vol. xii., p. 153.

Points out that though the Barnsley bed itself is approaching exhaustion, there are nine other seams at depths between 60 and 435 yards beneath it which might be worked.

488. Briart, Mons.—The Coal Formation.

"Colliery Guardian," vol. lxi., pp. 68, 101, 144, 207, 246.

Translated from a memoir read to the Academie Royale de Belgique

It is principally occupied by a discussion of the method of formation of coal, whether on the spot or by transport. The latter view is supported by Fayal, Grand' Eury, and De Lapparent, but he argues against it in the usual way. The boulders are brought by masses of wood floating to the swamps where the coal was growing.

489. Anon.—The Coal-fields of the United Kingdom.

"Colliery Guardian," vol. lxii., pp. 195, &c., to 1,009.

A series of eighteen articles on the various coal-fields mentioning the principal coals, their position and character, and output during the last 30 years.

489a. Nasse, R.—Economic and Comparative Notices on the Coal-Working in Durham and Northumberland.

Zeit. Borg.-Hütten and Sal. Wesen in Preuss. St., Band xxxix., p. 282.

A general account of the Durham Coal-field, giving the number of the beds, the thickness of the strata, the varieties of coal, the output and the cost of getting.

490. M. E.—The Forest of Dean Coal-field.

"Colliery Guardian," vol. lxii.,, p. 609, 664, 709, 794.

Giving details of the characters of the coals, &c.

491. M. E.—The South Wales Coal-field.

"Colliery Guardian," vol. lxi., p. 840.

Mostly occupied with the workings of the collieries, but a few geological notes are interspersed.

491a. Brown, T. F.—The South Wales Coal-field.

Handbook for Cardiff and District. Cardiff: 8vo, pp. 100—130.

A general account of the strata, mode of working, and output.

492. M. E.—Gloucestershire and Somersetshire Coal-field.

"Colliery Guardian," vol. lxii., pp. 148, 183, 226, 268, 315, 352, 397, 439, 482, 572, 568.

Eleven articles on the various mines, giving numerous details of strata.

493. M. E.—Nottinghamshire Coal-field.

"Colliery Guardian," vol. lxii., p. 889.

Gives the section at Shireoaks Colliery and neighbouring workings through 3,951 ft.

494. Taylor, J. E. — Coal in the Eastern Counties.

"Colliery Guardian," vol. lxi., p. 657.

Believes that the Coal-measures will be found prolific on the north side of the Palæozoic axis, the direction of which is indicated by the Essex earthquake of 1884, and recommends boring in the valley of the Stour.

495. Whitaker, W.—Suggestions on Sites for Coal-search in the South-East of England.

Rept. Brit. Assoc. for 1890, p. 819.

Published during 1890 in the Geol. Mag. [*See* No. **171**, 1890.]

__496. Dawkins, W. B.—The Search for Coal in the South of England.__

Proc. Roy. Inst., vol. xiii., pt. i., No. 84, p. 175.

The Palæozoic rocks below the South of England are considered to run with an east and west strike, so that the Silurian being at Ware, and the Devonian at Richmond, we must go south for the Coal-measures; also the South Wales synclinal is considered to be continued to the Harwich boring. Dover was therefore considered to be on the line of Coal-measures, and a boring was recommended in sight of Calais, where Coal-measures had been met with by boring, and near the spot where a bituminous mass was found in the chalk.

The following section is given:—[1]

Lower Grey Chalk and Chalk Marl, Glauconitic Marl, Gault, and Neocomian	500
Portlandian, Kimmeridgian, Corallian, Oxfordian, Callovian, Bathonian	660
Coal-measures, sandstones, and shales and clays, with one seam of coal	70

Thus the Oolites are half the thickness of those at Netherfield, and there is no Wealden. He considers this to be one of a chain of coal-fields which will extend in long narrow east and west troughs beneath the line of the North Downs.

__497. Ussher, W. A. E.—On the Probable Nature and Distribution of the Palæozoic Strata beneath the Secondary, &c., Rocks of the Southern Coun-__

[1] The dip in the diagrams is given as 43°, but the direction is entirely unknown. *See* No. **499** as to possible north and south folds.

ties, with Special Reference to the Prospects of Obtaining Coal by Boring South of the Mendips.

Proc. Somersetshire Arch. and Nat. Hist. Soc., vol. xxxvi., p. 82, with two coloured maps and a plate.

After considering the bearings of the various south-eastern borings, the author shows that the Culm-measures are conformable to the Devonian, and in their lower part correspond generally to the Carboniferous Limestone, and in their upper part to nothing higher than the base of the Coal-measures. The occurrence of an outlier of Carboniferous Limestone only 10 miles east of the Culm Basin at Cannington indicates a rapid change of type. The main strikes throughout are east and west. The author here makes a digression to withdraw his idea of the laccolitic origin of the Devon granite, and to propose, in its place, the hypothesis that the granite belongs to an older mass than the surrounding rocks, and that the alteration round it is due to reheating on pressure, but he does not here enter into the reasons for these views.

On the South Coast the Trias seems to be 3,000 ft. thick, but it thins towards the Mendips. The Culm basin has a straight northern boundary; if we continue this eastwards towards Portsmouth, we get the best chance of coal on the south of this line, but not too far south nor west of Axminster. This coal would be in synclinal basins containing higher beds than those seen in the Culm area. He considers, however, that there is a concealed fault running easterly from Cannington Park, either N. or S. of Glastonbury, which may complicate matters. The whole question can only be settled by actual boring, but the most probable location of a coal basin would be within a line drawn from Otterhampton to Pawlet, and thence by Meare, Polsham, Wedmore, Badgeworth, Lympsham, and Bream. Within this line the best sites would be Highbridge, Burnham, Berrow, East Brent, Chapel Allerton, Wedmore, Meare, and Mark. The Palæozoics would here be reached at less than 1,000 ft. As an epilogue, the author gives a section to explain the inversion at Vobster near the Mendips. He thinks the anticlinal crest of the Carboniferous Limestone has been let down from the Mendips on the south on to the top of the Coal-measures, along a fault, making about 20° with the horizon.[1]

***498. Bell, W. H.—The Buried Palæozoic Rocks of Wiltshire.**

Wiltshire Arch. and Nat. Hist. Mag., vol. xxv., p. 80, with three plates and three sections.

The three plates are from Jukes-Browne's "Building of

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[1] This is called a "thrust," and an arrow is drawn sloping *down* it. In thrusts, however, the rocks are supposed to be thrust *up*.

the British Isles." The third section is a horizontal one from Vallis to the east of Westbury. A general account is given of the meaning of the various strata, and of the unconformity, and then a discussion on the question of coal beneath Westbury. The section represents a steady easterly dip from near Frome, which is considered likely to bring in the coals, but no actual evidence is available.

499. Lucas, J.—Report of Lieut.-Colonel W. G. Dawkins on the prospect of finding Coal under the Estate of Over Norton, Oxfordshire.

London: 8vo. Privately printed. (In Library of Geol. Soc.)

He considers that the Bristol coal-field is bounded on the east by a continuation southwards of the Woolhope and Mayhill axis—and that beyond this should come the representative of the South Staffordshire and Warwickshire coal-fields; another Silurian axis runs north-west and south-east through Ware, and east of this again comes the Dover coal-field. This second axis is the continuation of the Pennine and Charnwood axis—and runs below London. Its elevation falls from 686′ 6″ below O.D. at Ware to 1,222′ 6″ below O.D. at Richmond, and it probably still falls to the west, where Jurassic and Triassic strata come gradually in which may reach 2,600 ft. This fall would not be continued to the west fast enough to cut out the Coal-measures. Two sections are given intersecting at Chipping Norton showing only Lias and New Red Sandstone to be pierced before reaching Coal-measures dipping north-west, that is to say that Chipping Norton lies in the eastern part of the continuation southwards of the S. Staffordshire and Warwickshire Coal basin. He expects the Coal-measures to be reached at 1,000 ft. and to show 500 ft. of Middle Measures. The amount of coal in these is 26 ft. in Warwickshire and 5 ft. in the Bristol area.

BUILDING AND ROAD STONES.

500. Brownridge, C.—Our Walls and Pavements.

Trans. Leeds Geol. Assoc., pt. vi., p. 33.

The following are the stones used in Leeds for building, in addition to the local flags:—Shap and Peterhead granites, Corsehill stone, Mansfield Red, Hopton Wood, Ancaster, Bath. The paving stones, besides the Rough Rock, are the Cockfield and Middleton whinstones, Llanbedrog, Pwllheli, Threlkeld, Mount Sorrel, Penmaenmawr, and Port Nant.

501. Wallis, A. M.—The Portland Stone Quarries.

Proc. Dorset N. H. and Ant. Field Club, vol. xii., p. 187.

A description of the various beds and the method of getting the stone.

502. Livett, G. M.—Local Buildings and Building Stones.

"The Rochester Naturalist," vol. ii., p. 33.

The Sarsen stones, a tufa probably from France, used by the Romans and Normans, the Caen stone, Firestone, Kentish Rag, and Sussex marble, have been used in the neighbourhood. Shafts have been found in Rochester Cathedral made of a stalagmite not known *in situ* either in England or France.

503. Morton, G. H.—Geology of the Country around Liverpool, p. 16. [*See* No. **91.**]

The building stones used in Liverpool are:—

Ancaster Stone ..	At Central Station, County Sessions House.
Keuper Sandstone ..	At Customs House, Exchange, Jubilee Clock Tower (base), Lime Street Station, Liverpool College, Philharmonic Hall, Town Hall, nine Churches, and Wellington Monument.
Upper Pebble Beds	Water Tower.
Lower Pebble Beds	St. Cyprians, Wavertree Clock Tower.
Coal-measures, Cefn	Free Public Museum, St. Luke's, Walker, St. John's Market, Art Gallery.
Darley Dale	Municipal Offices, St. George's Hall.
Yoredale Series ..	Exchange Station.

[Compare No. **619,** 1890.]

Thirty million gallons of water are derived from wells in an area of 50 square miles around Liverpool, which is more than the rainfall on the area can supply.

504. Lupton, A.—A Gold Mine, a Slate Mine, and a Salt Mine.

Trans. Leeds Geol. Assoc., pt. vi., p. 18.

A general account of the method of working these materials in Britain and elsewhere.

504a. Jones, J. H.—The Economic Aspects of the Geology of Caithness.

Journ. Liverpool Geol. Assoc., vol. xi., p. 31.

The Caithness rocks present three main subdivisions:—I. A coarse conglomerate, which is useless, with fine-grained sandstones, which make good building stones. II. Yellow and red sandstones, with dark bituminous flagstones and limestones. The flags are less used now than formerly; the best are found 30 ft. below the surface; and some are used for roofing. The sandstones form good building stones. III. Yellow and red sandstones with mottled marls, yielding good building stones at Dunnet. The clays are chiefly employed as a substitute for mortar.

WATER SUPPLY.

505. Harrison, J. T.—On the Subterranean Water in the Chalk Formation of the Upper Thames, and its Relation to the Supply of London.

Min. Proc. Inst. Civil. Eng., vol. cv., p. 2, with plates i., ii.

From Mr. Dickinson's experiments 10·65 inches out of 27·843 inches percolated through 3 ft. of chalk; from Lawes and Gilbert's experiments 13·241 inches out of 31·451 inches percolated through 5 ft.; and from Mr. Braithwaite's data on the Wandle 13½ inches sink through and escape from the chalk. Taking the lowest of these, 10½ inches of rainfall has to be accounted for by springs and rivers.

He estimates the Chalk gathering ground of the Thames, Kennet, Wye, Colne, and Lea as 1,200 square miles, and the daily discharge where these rivers leave the Chalk as 250 million gallons. This accounts for only 5 inches, and he asks what becomes of the other 5½ inches. He points out that the lowest level at which the Chalk crops out from below the London Clay is at Datchet, 47 ft. above O.D. This must, therefore, form a weir over which the surplus water runs. It is covered by gravel from 12 ft. to 30 ft. thick, which extends westward to Maidenhead. This gravel bed acts as a reservoir which supplies the Thames. Thus between Maidenhead and Windsor, in April, 1884, there was an increment of 137 million gallons per day, and on July 8th, 10th, and 22nd, 36, 43, and 17 million gallons respectively (variations which may be accounted for by the different levels maintained between the locks). Below Datchet the gravel bed, as limited by the author, contains an area of 40 square miles, and he calls it "the Windsor gravel-bed." This bed, between Windsor and Thames Ditton, caused an increment in April, 1884, of 112½ million gallons per day, and on July 8th and July 22nd 13 and 114 millions respectively. Its capacity is also indicated by the seething wells at Kingston. Another and larger gravel bed, which he calls that of Slough, is cut off from the last by an uprise of London Clay between Colnbrook and Kingston; it covers an area of 50 square miles. That immense quantities of water ran to waste out of this is shown by gaugings which have been made between Teddington and Kew in very dry weather, which gave increments on two occasions of 430 and 440 million gallons per day. The water in these two gravel beds he considers to have come from the Chalk—the Windsor bed draining 630 square miles, and the Slough bed 578 square miles—the former directly, the latter through the Tertiary sands, down the hill, and over the London Clay.

If the Colne and the Lea carry off 5 inches, and 13 inches in all sink in, there are 8 inches left which, falling on 578

square miles, would yield 226 million gallons a day, and it is from this source, *i.e.*, the Slough gravel-bed, that he would supply London with water. The plates are a map and sections.

The following gaugings are given of the Thames in million gallons daily :—

	1865.	Nov., 1890.	
At Wallingford ..	240	180	Exclusive of the Kennet
Maidenhead ..	320	246	and Loddon.
Increment ..	80	66	

	April, 1884.	July 8.	10.	
At Maidenhead ..	673	417	373	Exclusive of the
Hampton ..	923	466	504	Colne and Wey.
Increment ..	250	49	131	

	July 22, 1884.	July 23.	24.	25.	26.	Nov., 1890.	
At Maidenhead	336	380	397	391	385	346	With
Hampton	532	519	537	575	480	446	Tributaries.
Increment	196	139	140	184	95	100	

	Aug. 10, 1887.	Aug. 12.	Nov., 1890.
At Teddington ..	301	332	454
Kew	731	681	894
	430	349	440

Dr. Gilbert, p. 31, gives and discusses tables of the rainfall and drainage at Rothampsted—taken on uncropped ground through 20, 40, and 60 inches of soil—for 20 years. The 40-inch soil is a little more gravelly than the other two. The smaller quantities in the 60 in. gauge shows that some escapes upwards again. The following is the summary table. A. rainfall by $\frac{1}{1000}$th acre gauge. B., C., D., the percolation through 20 in., 40 in., 60 in. depth of soil:—

	A.	B.	C.	D.
1870–1	27·55	9·64	9.42	5·81
1871–2	29·02	9·69	9·39	8·24
1872–3	30·66	14·35	13·67	12·03
1873–4	21·69	5·74	5·40	3·94
1874–5	31·61	12·25	12·72	10·30
1875–6	31·98	14·75	16·87	15·46
1876–7	39·28	19·63	22·07	20·20
1877–8	32·65	14·72	16·44	14·80
1878–9	41·05	24·44	26·03	24·38
1879–80	21-36	6·89	7·39	6·50
1880–1	36·77	22·38	22·84	21·26
1881–2	32·31	15·81	16·08	14·32
1882–3	34·71	20·82	21·72	19·72
1883–4	25·77	11·86	12·00	11·21
1884–5	26·78	14·82	15·14	13·98
1885–6	31·02	17·37	18·41	16·57
1886–7	23·61	10·64	12·58	11·72
1887–8	30·50	13·96	15·58	14·67
1888–9	30·09	14·64	15·82	14·33
1889–90	27·43	13·16	13.60	12·74
Averages	30·29	14·38	15·16	13·61

The percolation depends not only on the amount of rainfall, but upon its distribution in winter or summer, as may be seen by one of the single year tables :—

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Rainfall	2·44	3·62	1·21	1·46	2·94	0·82
20 in. percolation ..	0·77	2·45	0·93	1·29	2·42	0·48
	Mar.	Apr.	May.	June.	July.	Aug.
Rainfall	2·78	1·31	1·38	2·40	4·56	2·51
20 in percolation ..	1·71	0·01	0·12	0·06	2·76	0·16

The average percolation in 20 years being 3·89 in. in summer, and 9·72 in. in winter, showing that the percolation increases more rapidly than in the ratio to the rainfall.[1]

J. Hopkinson pointed out that in some years the percolation was only 3 ins., and that the Chalk area was partly covered by impermeable beds, hence the available amount of water might be reduced as a minimum to ⅛th the estimate.

J. Lucas said the Wendover spring indicated an actual percolation of 9 ins., and the same for the Wandle. The difference between this and the amount in the percolators is due to evaporation after percolation.

J. Mansergh pointed out that the water proposed to be abstracted from the gravel would be lost to the Thames, and that the gaugings between Teddington and Kew might be due to water which entered the gravel with the rising tide and came out again with the ebb, especially as the minimum flow was not maintained on an average more than 30 minutes.

R. F. Grantham confirmed the existence of much water between Slough and Dorney within 4 ft. of the surface, showing a fall of 7—8 ft. in a mile, between two wells.

M. Pierce stated the method by which he had gauged the river between Teddington and Kew. The velocity was estimated by means of floats passing from one stake to another at measured distances apart.

The author replied that the water could not get into the gravel bed from the river, because the low tide level of the river was 5·67 ft. above O.D. at a spot where the water was at 15 ft. above O.D. in wells near the bank, and this latter height is not much affected by the tide.

*506. Hopkinson, J.—Water and Water Supply with Special Reference to the Supply of London from the Chalk of Hertfordshire.

Trans. Hertfordshire Nat. Hist. Soc. and Field Club, vol. vi., pt. 5, p. 129, pl. iv.

This paper commences with the ordinary details about water, and then states that the rainfall in England is decreasing, because, 1, the heat of the earth is decreasing, so the

[1] Probably a varying amount evaporates before any percolates at all.

boiling point layer is lower down; 2, the height of the hills is lowered by denudation[1]; 3, the forests have been cut down. The problem of water supply depends on observation of rain evaporation and percolation gauges—those in use being described. The mean annual rainfall of Hertfordshire is about 26¼ in. for the last half century, which is greater than that of the previous one. The variations are such that the driest year may show only 69 per cent. of the mean; the two driest consecutive years an average of 74, and the three driest consecutive years an average of 79 per cent. of the mean. The evaporation from ponds has not been observed in Hertfordshire, but in neighbouring counties with a rainfall of 25½ in. the evaporation has amounted to 15½, 18, and 20½ in. in various circumstances. Similarly, a percolation of 6·85 out of 25·76 in., and 6·94 out of 28·18 in. has been observed through grass-covered soil. It is concluded that out of the 26¼ in. in Hertfordshire, 6¼ in. percolate through 3 ft. of grass-covered soil, or 6 in. to greater depths. It is then pointed out that as rivers are produced by the overflow of the water for which there is no room in the strata, any abstraction of water from the rocks lessens their flow. Owing to the direction of the fissures and the dip of the flint layers which guide the underground flow, abstraction from the valley of the Lea affects the Colne, and possibly even the Ouse. Details are then given of the growth of the London water-supply, which now reaches 165 million gallons daily, of which 10 millions are taken from the northern Chalk. The result is that the water-level below London has been reduced between 100 and 200 ft. in the last century, and it is shown by records that the water-level in Hertfordshire was formerly much higher than at present, and this has taken place noticeably even in the last twenty years, at the rate, in some cases, of 1 ft. per annum. The percolable area in the catchment-basin of the Lea and Colne is not more than 400 square miles. In dry years the whole percolation of this area would only supply one-third of London.

The actual depletion is doubtless slow, but its restoration would be still slower. Taking the thickness of the Chalk at less than 700 ft., it would take 400 years to fill it. Any abstraction of chalk water is therefore strongly deprecated, especially as when more is taken the danger of contamination is increased, and therefore the Bala Lake scheme is recommended, which, yielding a purer water, would save half a million per annum in soap.

507. Pearson, H. W.—Some of the Water-Bearing Strata and Wells sunk in the same,

[1] These are, surely, quite inappreciable in our time.

with Special Reference to Wells in the New Red Sandstone Formation.

Proc. Bristol Nat. Soc., vol. vi., pt. iii., p. 327.

A general discussion of miscellaneous matters connected with water supply. Describes the sinking of a well at Chelvey, near Yatton, yielding 1½ million gallons daily.

508. Shore, T. W.—Springs and Streams of Hampshire.

Papers and Proc. Hampshire Field Club, vol. ii., p. 33.

A general description of the rivers and their tributaries, and the beds which supply the springs.

***509. Timmins, A.—Analysis of Water from Spon Bore Hole, Coventry.**

[*See* **De Rance, C. E.**, No. **279.**]

Total solids per gallon, 561·05 grains; sulphuric anhydride, 239·91; lime, 37·80; magnesia, 12·09; chlorine, 66·10. These, according to Dr. Meymott Tidy, are probably represented by lime and magnesia carbonates, 27; do. sulphates, 90; alkaline sulphates, 300; salt, 135, &c. The analyses of 11 other known saline springs are quoted for comparison with this.

MISCELLANEOUS.

***510. Topley, W.—Geology in its relation to Hygiene.**

Presidential Address to Section III. Trans. Sanitary Institute, vol. xi., p. 215.

Gives an account of the relation of water supply to the geological structure in the Weald district. The Asdown sands only yield a supply when the outcrop is near, no water being obtained at Cuckfield. Deep borings at Hastings, Rye, and Lydd have also failed. The Hastings beds yield good water in wells at Stammerham. The Lower Greensand, when bored into, does not generally yield well, as near London, and at Firle, where it is very thin. The distribution of water in the Chalk and Lower Greensand has affected the position of parishes, for in 119 out of 125 cases the Chalk escarpment of the South Downs belongs to parishes below it, while in 88 out of 103 cases the Lower Greensand escarpment belongs to villages above it. Much water from the Chalk at Brighton escapes to the sea. As to diseases, the question of the distribution of goitre is discussed, and it is shown that it is not calcareous nor ferruginous water that produces it, but it may be iron sulphides.[1]

[1] Can it possibly be due to fluorine? Flucr spar is abundant in the Mountain Limestone of Derbyshire, a county noted for goitre.

511. Miller, H.—Landscape Geology.

Edinburgh: Blackwood & Sons. pp. 63.

A plea for the study of geology by landscape painters. An address to the Edinburgh Geological Society. He endeavours to show that science and art are not diametrically opposed, and that the artist can grasp Nature better from a study of geology, illustrating his remarks by dealing with mountain form and expression in rocks.

512. McConnell.—Agricultural Geology.

Bath and West and South Counties Soc. Journ., vol. i.

Not seen.

MAPS AND SECTIONS.

ENGLISH MAPS.

***513. Sheet No. 80, S.E.—Cheshire, Solid and Drift.**

The Solid map shows only one rock, the Keuper Marl, with the exception of a very minute S.E. corner, where Waterstones occur. The Drift edition shows that this is almost entirely covered, except along the course of the Weaver and its tributaries. The superficial deposits are Upper and Lower Boulder Clay and intervening inconstant Middle Sand, the former occupying about three times the area of the latter, which is very irregularly distributed.

***514. Sheet No. 99, S.E.—Drift Edition.**

A small fragment including Bootle, almost all covered with Boulder Clay, and a little gravel. With this map a general index of colours for the south part of the Lake District is given, in which the St. Bees Sandstone is now marked as Trias, and labelled fb, the only Permian rocks admitted being a thin band of "Breccia e" and "Magnesian Limestone e."

***515. Sheet No. 99, N.E.—Drift Edition.**

The solid rocks here only appear in small patches. Boulder Clay occupies most of the high ground, and gravels and sand most of the low. The only Permian rock is a thin "Breccia e"; the rest is Lower Silurian and "Trias fb."

***516. Sheet No. 106, S.W.—Solid and Drift.**

The "Solid" map is divided into two by a north and south fault (the Pennine); on the east side of this are the Carboniferous rocks. The Coal-measures occupy a small area running east and west along a trough which has been let down by a far-reaching fault on the south. They include the Craignook or Seven-quarter coal, 5 ft.; the Wellside or Coomroof coal 4—5 ft.; the Great Midgeholme, 3—6 ft., and the Little Midgeholme.

The Millstone Grit with two bands of shale follows to the north and caps some of the hills to the south. The rest is occupied by Carboniferous Limestones and shales. The outcrops of the former indicate that the dip is nowhere large, but on the whole to the E. and partly to the south. The upper part is called the "Slate Sills" and comprises the Grindstone Sill, Upper and Lower Felltop Limestones and Firestone Sill. Below this the beds are not called Yoredales, but the Little, Great, Four Fathom, Three Yards, and Five Yards Limestones are marked, with the Top and Low Tindale and Hynam coals, and below this the Scar Limestone, no thicker than the others but split up into several, labelled a—o, of which the Cockle Shell, Single Post, Tyne Bottom, and Melmerby Scar Limestones are named.

The Whin Sill is marked in various places where it is limited by faults.

On the west side the Triassic rocks mapped are; f6 red and green shales, fc Kirklinton Sandstone, together called Keuper; fb St. Bees Sandstone and fa gypseous shales together called Bunter, while the Permian is represented by the Penrith Sandstone alone. f6 is only shown on the west side of the map, south of Kirklinton and fc curves round it on the east. The Permian and fa are found only on the south side of a supposed fault, but in the south there is a succession up to fb, the lower beds apparently forming an anticlinal.

The Drift map shows "Glacial" deposits, viz., "Eskers or Kames" (sand and gravel) and "earthy gravel and Till." Most of the high ground is uncovered, but the Till rises to above 875 ft. in the north, and the Eskers, &c., form a broad, irregular, circular zone round the western margin of the Carboniferous area and along the valley of the Irthing.

Three successive river terraces are marked along this valley.

***517. Sheet No. 110, S.E.—Solid and Drift.**

Part of Northumberland, south of Holy Island. The whole of the sedimentary deposits are called the "Carboniferous Limestones series, d 2 & 3," all being coloured with one tint. The whole, however, is divided into four groups—the Calcareous or Limestone, the Carbonaceous or Scremerston coal, the Arenaceous or Fell Sandstone, the Tuedian or Cement Stone. In these the outcrops, noted in descending order, are of Lickar Coals, Dryburn Limestone, Lowdean Limestone, Acre Limestone, Eekwell Limestone, Coal 3—4 ft. Oxford Limestone, Greenses Coal, Woodend Coal, Woodend Limestone, Dun Limestone, Fawcet Coal, Blackhill Coal, Main Coal, Cooper Eye Coal, Wester Coal.

The only other rock is intrusive basalt, which occurs in

[illegible] 50, 56.

[illegible] 20–22.

[illegible] (N.E., S.E.), 41, [illegible]

[illegible] (N.E.), 25 (N.E., N.W., [illegible] S.E., [illegible] N.E.

[illegible] sheets [illegible] (S.E., S.W.), 5 (S.E., S.W.), [illegible] (S.W., N.W.), 10 (S.E.), 11, 12 [illegible] N.W.), 14 (S.W.), 15 (N.E., S.E.), 16 [illegible] N.E.), 18 (N.W.), 19 (N.W.), 20 (N.E., S.E.,

N.W.), 21, 22 (N.W.), 24 (N.E.), 32 (S.W., S.E.), 33 (S.E.), 34 (pt.).

Cambridgeshire. Sheets 45, 48, 52 (S.W., S.E., N.E.).

Buckinghamshire. Sheets 2, 3, 5, 6, 11, 20, 24 (S.E.), 30 (pt.), 35 (pt.), 39 (pt.).

Hertfordshire. Sheets 19, 26, 28, 33, 34.

Berkshire. Sheets 26, 27, 34, 35, 43.

Wiltshire. Sheet 49.

Kent. Sheets 39–41, 49–54, 61–64, 71, 72.

Surrey. Sheets 16, 22, 25, 27, 28, 30–43, 45–47.

Sussex. Sheets 2, 12, 13, 34, 35, 47–54, 60–68, 72–75, 77–82.

Hants. Sheets 3, 17, 23, 25, 31–34, 37, 39–42, 45, 49–51, 89–100.

Dorset. Sheets 38 (S.E.), 39 (S.W.), 45 (N.E., S.E.), 46, 47, 48 (S.E., S.W., N.W.), 49 (S.W.), 52 (N.E., S.E.), 53, 54 (N.E., S.E., S.W.), 55, 56, 57 (N.W., S.W.), 58, 59 (N.E., N.W.), 60.

519. Sheet No. 31.—Revised Edition.

The revision in this map consists in colouring a triangular area to the east of Ballyshannon as Archæan gneiss instead of quartzite and quartz schist, and marking the coast band of the overlying Carboniferous rocks by a distinct colour. The "quartizes and mica-schists and gneiss" on the north side of Donegal Bay are left as they were.

520. Sheet No. 32.—Revised Edition.

The revision consists in colouring the large area round Lough Derg, and from thence to Ballyshannon as "Archæan Rocks—Gneiss with later basic dykes," the dykes not being inserted; in place of two distinct colours for "quartzite and quartz schist" and "mica schist and gneiss." The boundary lines between these two, and all the faults within the area, are done away with. The overlying Lower Carboniferous on the west side is marked as having a natural boundary throughout, instead of a faulted one in places.

HORIZONTAL SECTIONS.

521. Ireland, Sheet No. 31.

From the River Lagan, S. of Belfast, in a N.N.W. direction to Bengore Head, Giant's Causeway, by Templepatrick, Tardree Mountain and Ballymena.

Beneath the Blackstaff river, Belfast, is "pale red and yellow sandstone, with thin shaly layers (Bunter)" dipping N. 36° W. This is followed on the dip by "thin-bedded red and grey sandstone and marls (Keuper) of considerable thickness." At Legoniel is a small band of "Rhætic," overlain by "Lower Lias," which rapidly dies out beneath a

narrow continuous band of "Upper Greensand." Above is "Chalk with flints," the surface of which is irregular, and is covered by a thick mass of "Lower Basaltic sheets." This forms the general basis of the whole section. At two places —one near the junction of the 6 in. sheets 56 and 51, and the other near Hamillstown—there is an overlying thin band of "Pisolitic Iron ore," overlain by an "Upper Basalt sheet," in each case represented as connected with one of the many basaltic dykes that cross the strata vertically. The Chalk is faulted to the surface again at Upton Castle Demesne, and there is a long mass of "trachyte porphyry," of which the centre is Tardree Mountain, on either side of which is an outlying boss. This mass of trachyte is described as "white felspathic ground mass containing crystals of sanidine, smoke-quartz, and minute crystals of biotite, tridymite, &c." A thin bed of Boulder Clay covers a large part of the surface.

522. Ireland, Sheet No. 32.

From River Shannon, 3 miles S.W. of Drumshambo, across Slieve Anicrin and Cuilcagh, by Florence Court, Arney Bridge, and Enniskillen. The section runs N. 43°—32° E. On the south-west, near the Shannon, is a low plain of Lower Carboniferous Sandstone, underlain N.E. by Lower Silurian greenish grits. Then there is a fault beyond which only higher beds occur, at first with a sharp dip to N.E. The series commences with the Calp (or "black carbonaceous shales, with thin bands of limestone") and Upper Limestone, which begin to form a gentle synclinal, towards the centre of which the Yoredale Sandstone commences in a tongue, and thickens rapidly. Above this is a thick mass of "Yoredale Shales with ironstone bands and nodules." The hills are outliers of younger rocks. Slieve Anicrin (1,922 ft.) shows Millstone Grit, with the Crow Coal and Main Coal overlain by the Lower Coal-measure Shales. Knockcullian (1,875 ft.) reaches the Millstone Grit only, but Gubnaveagh (1,707 ft.) has a thin capping of Lower Coal-measures. Cuilcagh (2,188 ft.) only just reaches the Millstone Grit; on account of the strata having reached the other side of the synclinal, which brings up in succession all the series again down to the Calp; and finally in the low ground as far as Enniskillen, the Lower Limestone Boulder Clay is confined to patches on the slopes and bottoms of the valleys.

523. Ireland, Sheet No. 34.

From the River Finn, west of Castlefinn, to the Atlantic Ocean, at Bloody Foreland, by Cronamuck, Derryveagh, and Errigal Mountains, co. Donegal. General direction N.W.

On the S.E., by Castle Finn, after a fault, come, in downward succession, thick limestone, thin band of quartzite, mica schist. This series is terminated downwards by a thrust

plane dipping S.E., below which are some more quartzite and mica schist. These are described as "blue crystalline and schistose limestone, with layers of calcareous schist," and "grey and black glossy mica schist, often pyritous, with occasional beds of limestone and quartzite." Below this comes a thick mass of "sheared quartzite" between two thrust planes, and below this some puckered limestones with mica-schists immediately underneath, without any intervening quartzite, a band of which, however, lies in the midst of the schist. Then, after some intrusive diorite, comes a long undulating stretch of "fissile mica schist with beds of quartz schist," "light and grey siliceous mica schist, often highly gneissose," and "grey and green micaceous, chloritic and quartzose schists with calcareous bands." These culminate in Cronamuck (1,134 ft.). On crossing the Swilly, we enter a region conspicuous for its abundant diorite dykes and sheets, which stand more or less vertical with the schists and quartzites, or are puckered up with them. The rocks are described as "grey grits (quartzites) and shales (indurated) with intrusive sheets and dykes of diorite," and "light and dark grey quartzose, micaceous and steatitic schists, with beds of blue, grey, buff, and white limestone (occasionally dolomitic and serpentinous)." The Derryveagh Mountains (1,599 ft.), from the river Bullaba to the base of Errigal, are composed entirely of granite, described as "grey, and occasionally light brown and reddish granite, often containing caught-up masses of the adjoining schists, and penetrated by Tertiary basalt dykes which have a general north-west trend, and vary in thickness from an inch to several feet. The granite is intrusive into the schists and limestones on the north-west and south-east."

Errigal (2,466 ft.) is represented as having granite at its base, intruding into diorite, which itself intrudes into mica schists with limestone bands, and above is a thick mass of quartzite, affected by two thrust planes with a sharp synclinal between—the summit is "formed of white flaggy and pink massive felspathic quartzite." Beyond this is an undulating country capped by massive quartzite, overlying, almost horizontally, flaggy schists and limestones, and the low ground to the Atlantic is of intrusive granite—red, with black mica. Boulder Clay occurs in occasional sheets on the low ground.

524. Ireland, Sheet No. 36.

No. 1.—From Donegal Bay in a N.N.E. direction to Reelan River by Donegal, Banagher Hill, Blue Stack, and Gaugin Mountains.

On the S.S.W. side, the section commences below the sea in Donegal Bay, with Calp-shale, and limestone, described

as "dark grey calcareous, occasionally pyritous shale, containing beds of bluish earthy limestone." This gradually rises to Banagher Hill (1,268 ft.), where the Calp Sandstone comes gradually in. From below rises the Lower Limestone and Lower Carboniferous Sandstone, described as "bluish-grey massive limestone overlain by coarse, light grey, and yellow pebbly sandstone, and overlying and intercalated with yellow and red coarse sandstone and purple conglomerate." After this a fault introduces a different country altogether. The Croaghgorm or Blue Stack Mountains are all of granite, represented as intrusive into "grey mica schist, with bands of limestone," with intercalated beds of quartzite, the thickest of which forms a gentle synclinal on the slope of Gaugin Mountain (1,865 ft.)

No. 2 is in a N.N.W. direction, over Slieve League and Glen Head, from Donegal Bay to the Atlantic.

Slieve League (1,972 ft.) is composed of nearly horizontal beds of "grey and pink flaggy quartzite, overlying grey mica schist with limestone and siliceous bands, and capped by a Carboniferous outlier of coarse sandstone and quartzite conglomerate." From thence to Glen Bay the low ground consists of folded "dark leaden-coloured mica schists containing siliceous and thin limestone bands." Glen Head has a mass of diorite, and then, after a fault, a monoclinal fold of quartzite and schist dipping into the Atlantic.

FOREIGN GEOLOGY.

(Published in Britain.)

PHYSIOGRAPHY.

525. Stirrup, M.—Earth Sculpture, as illustrated in the Gorges of the Tarn, and at Montpellier le Vieux, Southern France.

Journ. Manchester Geog. Soc., vol. vi., p. 364.

A general explanation of the origin of gorges, &c., as described in No. **658**, 1890.

526. Sjogren, H.—Transverse Valleys in the Eastern Caucasus.

Geol. Mag., Dec. 3, vol. viii., p. 392.

An account is here given of two gorges draining upland valleys. The first is on the north side of the Caucasus between this range and the Caspian. The drainage area of the River Sulak, which is known as Inner Daghestan, is completely sur-

rounded by mountains, the Caucasus being on the south-west. The higher parts of this district are Liassic and older. The lower parts are Jurassic and Cretaceous, the latter being thrown into anticlinals, with their sharpest slopes inside, to form the bounding range on the north-east. Tertiary Beds are only found in Outer Daghestan. This region has therefore been land since the commencement of the Tertiary Period, and at first the drainage passed over the summit of what is now the bounding range of mountains, but the regions behind have been slowly lowered, while the outlet has become a deep gorge having a vertical depth of between 5,000 and 6,000 ft., with perpendicular sides, and so narrow that only a horse-path can be made between the river and its cliffs. The other valley, Gerdiman-tschag, on the south side of the Caucasus, shows similar features on a smaller scale, and is similarly interpreted.

527. Howorth, H. H.—On the very Recent and Rapid Elevation of the Highlands of Eastern Asia. Geol. Mag., Dec. 3, vol. viii., pp. 97, 156.

The author considers it to have been decisively proved that the Mammoth inhabited Siberia, where its remains are now found, and that the country must at that time have supported sufficient vegetation for its food, and indeed some remains of such vegetation have been found. How then has the change of climate been brought about? In the first place he considers that if the Arctic Sea were replaced by land the climate would be warmer, as the present ice is a source of cold. The main cause, however, of the cold is the chilling of the south winds by the great central plateau of Asia. Hence, he argues, this plateau could have had no existence in the Mammoth age. It is to the proof of this from various sources that the present paper is devoted.

First the Altai Mountains, as described by various observers, show no traces of glacial action, or erratic blocks, whence he concludes they did not exist during the Glacial Period. Moreover, the Hyena, a dweller on warm plains, is found in cave deposits on these mountains. He then quotes Severtzoff to show that the Tian Shan Mountains show no traces of former great glacial development, and Gottsche to show the same of Korea, and Campbell of the Himalayas, though the present glaciers may have been larger. In the same way, McMahon could see no evidence of a Himalayan ice-cap, nor of the descent of glaciers below 11,000 ft. These mountains also must, therefore, have been elevated since Glacial times. By the accounts of several travellers quoted, it is shown that the uplands which spread out into the desert of Gobi contain much salt, they are, therefore, considered to be the very recently desiccated bed of a sea, on

which lie great deposits of horizontal gravel. He next mentions the bones of horses and rhinoceros, which have been found in horizontal superficial deposits at a height of 15,000 ft., and since these latter require trees for feeding on, of which none can exist at this elevation, the ground must have been raised since they died. The objection that the beds could not have remained horizontal after such an elevation, he meets by observing that so great an elevation must be due to a widely operating cause, and not to local tilts; and the hypothesis of the previous existence of more water in the district would not aid the matter, as this would feed glaciers and not nourish trees at such an elevation. Similar evidence is derived from the occurrence of fresh-water shells, and on the whole he concludes that all this elevated tract has been materially raised in almost recent times.

***528. Blanford, W. T.—Note on the Age and Ancient Glaciers of the Himalayas.**

Geol. Mag., Dec. 3, vol. viii., p. 209.

This is a reply to H. H. Howorth's paper [No. **527**]. He points out that [as shown by R. D. Oldham, *see* No. **39**] the Upper Pliocene beds on the southern border of the range so closely resemble in material and coarseness those forming at the present day, that the geographical features of the district, *i.e.*, the mountains, must have been in existence even then. He controverts J. F. Campbell's evidence by saying he never entered the main Himalayan range. In Sikkim, however, moraines are found between 7,000 and 8,000 ft., and thus the glaciers extended in Pleistocene times from 8,000 to 10,000 ft. lower than now, and the same is the case in Cashmir. The apparent absence of glacier indications simply shows that the Himalayas being in a lower latitude than the Alps the glaciers never descended so low as there. He also considers the rhinoceros quoted to have been Pliocene, and finally he thinks the enormous ravines could scarcely have been excavated since the Mammoth lived.

529. Howorth, H. H.—The Recent and Rapid Elevation of the Himalayas.

Geol. Mag., Dec. 3, vol. viii., p. 294.

This is a rejoinder to the objections of W. T. Blanford [No. **528**]. What the author really maintains is not the non-extension of Himalayan glaciers beyond their present limits, but that the remains are "quite incommensurate in size and importance with the vast glacial *débris* and phenomena which should be found on the flanks and in the neighbourhood of these gigantic buttresses, if during the so-called Glacial Age they had formed the feature in the landscape which they do now," in which case he would have expected their signs even in the lower

valleys.[1] He quotes Mr. Blanford himself as saying that much of the elevation "is of post-Pliocene age"; he thinks it improbable that the rhinoceros lived at an elevation of 15,000 ft.; he points out that Lydekker *now* considers this animal to have been Pleistocene and not Pliocene; and he does not believe that the gorges have been carved out by rain and rivers at all, which to him would involve a *reductio ad absurdum* of Uniformitarian geology.

***530. Blanford, W. T.—The Age of the Himalayas.**

Geol. Mag., Dec. 3, vol. viii., p. 372.

Another reply to H. H. Howorth. He here reiterates his argument from latitude, and considers the salt deposits of the elevated deserts to be due to rivers with no outlet, and states that fine Eolian deposits are associated with them. The evidence doubtless appears strong at first sight, so that he was formerly led away by it. He confesses to have changed his opinion about the post-Pliocene elevation of the Tibetan Plateau, on account of the discovery of remains of *Pantholops* there, which it is as difficult to understand living on low ground as the rhinoceros on high ground. Moreover, Mr. Lydekker has now returned to the view of the Pliocene age of these deposits. He brings forward a very powerful argument from the mammalian distribution, viz., there is a very specialised fauna in Tibet, and "it is incredible that" this "can have been differentiated since Pleistocene times, and very improbable that it can have entirely developed since the Pliocene period."[2]

531. Upham, W.—Elevation and Subsidence during the Glacial Period.

Geol. Mag., Dec. 3, vol. viii., p. 92.

He states in reply to A. J. Jukes-Browne [No. **657**, 1890] that Pleistocene shells have been found by Dr. Maach at 763 ft. up at Panama, while the water-shed is only 300 ft., proving the submergence of the isthmus, which aided the production of glacial conditions by letting the Gulf Stream pass.

***532. Jukes-Browne, A. J.—Elevation and Subsidence in Central America.**

Geol. Mag., Dec. 3, vol. viii., p. 143.

Points outs that his difficulty is to account for North America being elevated and depressed (if it was so) at the same time that Central America was being depressed and elevated respectively. There is not a gradual change leading

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[1] The argument used about their being in a lower latitude is not considered.

[2] Mr. Howorth replies to this in February, 1892.

[illegible]

523. [illegible]

[illegible]

[illegible] western [illegible] water-shed [illegible]

[illegible] discusses the origin of these, and disposes [illegible] by general arguments. [illegible] the [illegible] which he considers [illegible] post-Pleistocene submergence is [illegible] amongst which he [illegible] Trynant. [illegible] which he considers to have been formed where [illegible] submergence.]

524. Dall, W. H.—[illegible] of America in the Tertiary Period.

[illegible]

[illegible] 524

[1] [illegible] paper is very difficult to follow for anyone not intimately [illegible] with American [illegible], the evidence adduced being in the form of a summary in which the localities and characters of the deposits [illegible] are supposed to be already known.

[2] [illegible] whether all these gravels, &c., are parts of [illegible] beaches or whether each may not be a distinct formation, [illegible] as some believe the Moel Tryfaen deposits to be, by local [illegible] of the great ice-sheet.

A letter calling in question the facts on which the conclusions of Mr. Upham's paper on Quaternary changes of level [No. **656**, 1890] are based. The Pleistocene fossils supposed to indicate post-Glacial depression of the Isthmus of Darien were found at 150 ft. only above present sea-level, while the summit, or dividing ridge, has yielded no Tertiary fossils. He also states that though there were great changes of level on the continent in Pleistocene times, "the Floridan region, for some unknown reason, escaped." In Eocene times Florida was an island, and its vertical changes since then have been small. Details in proof of this are promised.[1]

535. Upham, W.—Correlation of Quaternary Changes of Levels in North America and the Caribbean Sea.

Geol. Mag., Dec. 3, vol. viii., p. 330.

A reply to A. J. Jukes-Browne [No. **532**]. He considers that an east and west line of separation is indicated by a volcanic belt—and gives more details proving continental elevation. The discussion then drifts into generalities.

536. Howorth, H. H.—The Recent and Rapid Elevation of the American Cordilleras.

Geol. Mag., Dec. 3, vol. viii., p. 441.

The arguments in this paper depend upon quotations from various authors, from Humboldt to Geo. Dawson. From these we learn that the Rockies and Andes show no signs of glaciation below 8,000 ft., except between Chili and Patagonia. In a large part of South America, indeed, no stones of any kind are seen. In the northern part of the Rockies, while there are numerous erratics from the Cascade Range right up to their west flank, and others belonging to the eastern Drift up to the eastern flanks, the Rockies themselves throw off no erratics of their own. He argues thence that at the time of the dispersion of the erratics the Rockies, as a mountain chain, could have had no existence.[2] This conclusion is supported by the fact that they do not form a zoological boundary,[3] as the Cascade Range has done, the bones of the Mastodon being found on both sides, as also on the high ground, at 5,000 ft., in Peru. He considers that the abrupt way in which the Rockies rise out of the adjoining plains "assuredly" points to their cataclysmic origin. The recent elevation is also argued from the numerous salt lakes at high elevations, and the suddenness by the unstratified loess that covers so wide an

[1] These conclusions appear to be contrary to those of J. W. Spencer above, unless, indeed, there was a N. and S. axis of rest through Florida.

[2] The test of this theory would be the finding of eastern erratics on the western side of the Rockies, or *vice versâ*; if none such are found, it would appear that these mountains existed at least as a barrier.

[3] Compare W. T. Blanford's argument, No. **530**.

area of Pampas which he considers due to a wide-spread earth movement.[1]

537. Hull, E.—On the Physical Geology of Tennessee and adjoining districts in the United States of America.

Quart. Journ. Geol. Soc., vol. xxxvii., p. 69.

The district here discussed lies to the north-west of Chattanooga and north of the Tennessee river. On the east lies the Archaean Unaka ridge, then follows the valley of East Tennessee of Silurian rocks, and then the Cumberland plateau of nearly horizontal Devonian and Carboniferous rocks, which is traversed by the winding gorge of the Tennessee river, and cut into on the north-west by the valley of Sequatchee, which lies along a slight anticlinal, and beyond comes the Silurian uplift of Nashville. The only unconformity yet noticed in the succession is between the Lower and Upper Silurian on the east. The earth movements have produced one sharp uprise, followed westwards by a gentle synclinal and anticlinal. The valley of East Tennessee was produced by the greater erosion due to the higher elevation of the Unaka ridge, and thus the Cumberland plateau was left outstanding, but is continually eaten into by the river which runs at the base of its easterly escarpment. The gorge of the Tennessee through the plateau is caused by a low saddle only 250 ft. above its level on the south: at the time, therefore, that the river began to flow, this saddle was higher than the plateau, but has been since lowered by denudation, as in the case of our Wealden rivers.

538. Sibree, J.—The Volcanic Lake of Tritiva, Central Madagascar.

Proc. Roy. Geogr. Soc., vol. xiii., p. 477.

In the Vàkin Ankàratra region are some hot springs with waters like those of Vichy in composition. During the excavation for the bath-house remains of hippopotamus were found with the gelatine still in the bones. The lake Tritiva is 10 miles S.W. of Antsirabè, and is in the centre of an old crater, the sides of which are vertical.

STRATIGRAPHICAL GEOLOGY—EUROPE.

539. Harris, G. F., and Burrows, H. W.—The Eocene and Oligocene Beds of the Paris Basin.

Geol. Assoc., separate publication, pp. 130, with a map of the Paris Basin, scale $\frac{1}{16}$in. per mile. Price 5s. net.

This consists of three parts. The first is a summary with short notes of the various subdivisions of the Eocene and Oligocene, as adopted by French authors.

[1] It is not very clear how a *fine, uniform* deposit can be produced by "great terrestrial commotion."

The Eocene beds are divided as follows :—

Parisian	Ligurian	13. Gypsum and marls.
	Bartonian	12. Limestone of St. Ouen.
		11. Sables Moyens.
	Lutetian	10. Calcaire Grossier.
Suessionian	Ypresian	9. Sands of the Soissonnais.
	Sparnacian	8. Sands of Sinceny.
		7. Lignites of the Soissonnais.
		6. Plastic Clay.
	Maudunian	5. Rilly Limestone.
		4. Sands of La Fère.
		3. Sands of Bracheux.
		2. Marls of Meudon.
		1. Pisolitic Limestone.

Nos. 1—5 of these are local deposits each found resting directly on the Chalk. A general section of the plastic clay, No. 6, at Issy (Paris) from the notes of Dr. Hovelacque is given. The Lignites of the Soissonnais, No. 7, are local deposits. A section is given of the sands at Sinceny, No. 8, which are mostly fluviomarine. The sands of the Soissonnais are divisible into two horizons, viz., Upper = Sables de Cuise, and Lower = Sables d'Aizy, and a new section by the authors is given of the Upper beds at Cuise-la-Motte, and others at Héronval and Liancourt. Of the Calcaire Grossier, No. 10, there are two classifications: one by Michelot recognises four subdivisions, in 12 beds; the other, by Dollfus, recognises three only, the upper one being again subdivided into three, the whole being in 29 beds; while elsewhere an Upper or fluviomarine type is distinguished from a Lower or marine type. Sections are given of the Banc Vert, of the whole series at Arcueil from Dr. Hovelacque's notes, and at Grignon. The Sables Moyens, No. 11, are also divided into three, which are named after their typical localities, and sections are given at Auvers, Beauchamp, La Chapelle-en-Serval, and Le Guépelle, the last two from Dr. Hovelacque's notes. The Limestone of St. Ouen, No. 12, is lacustrine. The Gypsum beds and marls, No. 13, are divided into an Upper-Lacustrine and a Lower-Marine group of two beds each, and a section is given at Butte d'Orgemont from Dr. Hovelacque's notes.

The Oligocene beds are divided as follows :—

Aquitanian	13. Sands of the Gâtinais.
	12. Limestone of Beauce.
	11. Marls of Étampes.
Tongrian	10. Sands of Ormoy.
	9. Sands and Pebble Beds of Saclas.
	8. Falun of Pierrefitte.
	7. Sands of Vauroux.
	6. Pebbly Sands of Étrechy.
	5. Sands of Morigny.
	4. Falun of Jeurre.
	3. *Ostrea* marls and molasse of Etrechy.
	2. Limestone and Meulières of Brie.
	1. Green marls.

[illegible] Paris. [illegible] No. [illegible] directly. [illegible]

[illegible] sections [illegible] entries are [illegible]

[illegible] Rivers. [illegible] and [illegible]

[illegible] Ferme [illegible]

[illegible] Liancourt. [illegible] Noailles. [illegible]

[illegible] La [illegible] Ver. [illegible]

[illegible] Epernay. [illegible]

[illegible] Eocene and [illegible] given of [illegible] Echinodermata, [illegible] and Plants, and a complete list of 45 [illegible]

[illegible] Pelecypoda, 28 [illegible] and four [illegible]

[illegible] Pelecypoda, four [illegible] Pulmonata. [illegible]

[illegible] most part adopted from M. Coss- [illegible] but in four cases the authors differ from [illegible] have been altered by M. Cossmann [illegible] names are altered after R. B. Newton, [illegible] other generic names from the [illegible] they propose the following new names for [illegible] they have discovered to be preoccupied :—

[illegible] Cossmann : *Stegnomphalus* = [illegible] ; *T[illegible]stoma* = Pterostoma, Desh. ; *Cyrbasia* = [illegible] ; *Epetrium* = Stylia, Jousseaume ; *Ogivia* [illegible] Jousseaume; *Arcadactylus* = Ischnodactylus, [illegible] ; *Andmia* – Genea, Beilardi ; *Phlyctis* = Phlyctænia,

Cossmann; *Bathytoma* = Dolichotoma, Bellardi; *Asthenotoma* = Oligotoma, Bellardi; *Peratotoma* = Homotoma, Bellardi; *Liocarenus* = Fortisia, Bayan; *Micrelasma* = Anelasma, Cossmann; *Spartina* = Thaumasia, Albers. In an appendix, 50 new records by Cossmann are added to the Eocene fauna.[1]

540. Cooke, J. H.—Notes on the "Pleistocene Beds" of Gozo.

Geol. Mag., Dec. 3, vol. viii., p. 348.

The rocks composing the western side of Gozo are, in descending order, Upper Coralline Limestone, Green Sands, Marl, Globigerina Limestone, and Lower Limestone. A map of their distribution is given. The Dueira Valley is a synclinal let down in a trough between two faults, and consists principally of Globigerina Limestone. The Pleistocene Beds just noticed are in patches 30 yds. by 15 yds. on the slopes below the escarpment, on the south side. The upper part is a limestone full of minute ($\frac{1}{16}$ in.) perforations, snail shells and mammalian remains, the matrix containing also *remanié* fossils. Below is yellowish grey loam. This also contains land shells. Both contain pebbles of the limestones mentioned above, hardened stalagmitically outside, and also of a black limestone not discovered anywhere *in situ*. Other beds are found capping the hill on the opposite side of the fault, showing that the fault is later than these deposits. On the northern side of the valley there are similar deposits, but with larger boulders, scattered in layers with the loam, and bands of limestone, but without mammalia.

***541. Johnston-Lavis, H. J.—Geological Map of Monte Somma and Vesuvius, with a Short and Concise Account of the Eruptive Phenomena and Geology.**

London: Philip & Son, pp. 21. Map in 8 sheets, on a scale of 6·33 ins. to the mile.

The pamphlet is an explanation of the map. The history of the volcano is divided into several eras and phases. In the first era it must have been an island volcano, as lavas and pumices have been found to a depth of 591 ft. below the level of the plain. The second era produced Monte Somma of comparatively basic materials. The dykes, especially when hollow, indicate the source whence the parasitic cones were supplied. These dykes are indicated by numbers on the map and by corresponding white paint numbers on the dykes themselves. In the third era, Phase II., the volcano was dormant, and vegetable soil and valleys were formed. In Phase III., Period 1, the cone

[1] A comparison of the list given by these authors with that given by R. B. Newton, No. **334**, will show how far this renaming of genera tends to uniformity of nomenclature, at all events at present.

was truncated, and a thin layer of vitreous pumice was spread out. In Period 2 a darker lava poured out. Period 3 is indicated by rounded lapilli of dense leucitic lava. Period 4 produced a bed of leucitic breccia in the Valloni di Pollena and Grande, the fragments of which are very large, and their collection not easy to account for. Phase IV., Periods, 1, 2. The volcano now repaired its cone, great dykes were formed, and an almost pumiceous lava, with much sanidine and little leucite, was poured out; and at the Val San Severino another above this of more ordinary Vesuvian type. Phase V. was one of rest, indicated by the accumulation of vegetable soil. Phase VI. produced four explosive eruptions, each characterised by the emission of lighter pumice with porphyritic enclosures, followed by more microlitic, denser and darker varieties without leucite. The underlying Pleistocene Clays, &c., were thrown out in the beginning of Period 1, and the baked limestones below at the end. At the end of Period 4 the limestone must have been brought up from 800 metres below sea-level. After the pumice came, in each case, fine dust. All this is prehistoric.

Phase VII. commences with the eruption of A.D. 79. This and later eruptions have produced pumice with microlithic leucite. The wind was blowing from the north, so the deposit of pumice is to the south. In Pompeii it is separable into three divisions, 1, white vitreous pumice; 2, darker microcrystalline pumice; 3, pumiceous ash, usually pisolitic. There is no stratification in the Herculaneum mud which was brought down by water. There have been known eruptions in A.D. 203, 243, 305, 321, 471, 512, 780, which were probably explosive, and deposits of scoria and ashes remarkable for their large leucites, possibly corresponding to these, can be found. The eruptions of 1036—8, 1049, 1138—9, 1306, 1500, 1568, were probably paroxysmal rather than explosive, and went to build up the Vesuvian cone as drawn in 1631.

Phase VIII.—The eruption in 1631 was of the paroxysmal type, and besides the ejection of fragmental materials large streams of lava were poured out, and ever since parasitic cones have been produced, as the central column of lava has risen above some spot of weakness. Such craterets were formed in 1760, 1794, and 1861. The cone of Camaldoli, however, belongs probably to Phase IV. The lavas of these eruptions differ but little from those of Monte Somma, the larger the streams the finer the grain, and the more scoriaceous the surface, owing to the H_2O not having yet boiled off. During the recent phase, deposits of dense black lapilli have been formed—thickest near the crater, and gradually dying away.

In the map separate colours are employed for Phases I. and II., Phase III., Phase IV., Phases V. and VI.; Phases VII. and VIII. have each two colours. Green represents loose

material covered with vegetation, and red, "lavas and scorias and lapilli of Vesuvius." The bulk of the map is green. On this the courses of historic lava-streams are marked in red, which is spotted in green where overgrown with soil, and *vice versâ*. They mostly run south from the present crater. The earlier stages are seen almost exclusively in Monte Somma to the north of Vesuvius. The colour for Phases I., II. are seen all along the crest of the mountain, and in the valleys radiating from it. The other three, III., IV., VI., are seen only in thin strings in most of the radiating valleys, the first, Phase III., being most conspicuous in the Vallone Grande.

The map is in six sheets, and includes an area of about 90 square miles.

STRATIGRAPHICAL GEOLOGY—ASIA.

*542. Wynne, A. B.—Recent Geological Investigations in the Salt Range.

Geol. Mag., Dec. 3, vol. viii., p. 411.

This has reference to a paper by Mr. Middlemass on the Salt Range, in the Records of the Geol. Surv. of India, and states that the present writer's description was written before geologists were inoculated with the idea of thrusts, &c., now prevalent, and he found nothing in the Salt Range to suggest them ; nor can he understand how massive purple sandstones thrust over a substance like soft scum could produce a brecciated junction.

STRATIGRAPHICAL GEOLOGY—AFRICA.

543. Judd, J. W.—The Geology of Round Island.

" Nature," vol. xliii., p. 253.

Round Island is 13 miles N.E. of Mauritius. Specimens of rocks brought home by W. Scott show that it is entirely of organic and volcanic origin, viz., coral detritus and palagonite tuff, with scoriaceous olivine basalt.

*544. Hull, E.—A Sketch of the Geological History of Egypt and the Nile Valley.

Journ. Vict. Inst., vol. xxiv., with a map.

Gives a short summary of what is known. The Archæan rocks form the axis of the Arabian mountains; on their flanks lies the Nubian Sandstone, Carboniferous at the base, in Wady Arabah and elsewhere, and hence distinguished under the name " Desert Sandstone," but Lower Cretaceous at the summit. The Nummulitic Limestone is also nearly

conformable to the Cretaceous Limestone, and together they are 4,000 feet thick. To the Miocene period are assigned some low-lying deposits, and also a forest of silicified trees of the genus *Nicolia* in the Libyan Desert. The latest deposits are the raised beaches of Lower Egypt up to 220 feet. During Eocene times the sea extended to 12° N. lat., and in Miocene times the bounding Nile fault of 250 ft. throw was produced, thus determining the course of the river above Cairo. As the depth of the Nile alluvium is at least 200 feet, the country must have been so much higher at first. In the Pliocene period the country was depressed 220 ft. below its present level. The large river channels, now dry, indicate a former much greater rainfall during a time the author calls the "Pluvial Period," which was synchronous with the later stages of the Glacial epoch.

545. Alford, C. J.—Geological Features of the Transvaal, South Africa.

London: Stanford, 8vo, pp. 96, with eight plates and a Geological Map.

Five distinct types of rock are recognised:—1, Alluvial deposits, sand, peat, recent clays, and drift; 2, Siliceous sands and clays, with local beds of coal; 3, Sandstones passing into sandstone-quartzites, with interbedded conglomerates; 4, Clay, mudstones, schists, and shales, with beds of compact quartzite; 5, Trappean rocks, generally intrusive and of the greenstone class; 6, Granite rocks, granite syenite, gneiss, pegmatites, quartz porphyry, felsite rock and others. The alluvial deposits are all derived from the underlying rocks and include beds of bog iron ore and limestone. The coal formation contains only lenticular masses of coal, with thick beds of sandstone, usually horizontal. The auriferous sandstones and conglomerates are also for the most part horizontal, but are occasionally turned on edge. The schistose rocks are also sometimes auriferous, but are much contorted, and include a calcareous quartzite called elephant rock, from its weathering like an elephant's hide. The trappean rocks form dykes and sheets penetrating all the strata. The granitic rocks form the basement of the country.

The Witwatersrand district south of Pretoria is a high table-land 6,000 ft. above sea-level. The reefs are the upturned edges of the conglomerate beds; they include the *South Reef*, 6 in. to 3 ft., with gold up to 12 oz. per ton. To the north is the *Middle Reef*, 4 in. to 2 ft., sometimes rich in gold; the *Main Reef Leader*, 6 in. to 2 ft., with gold up to 8 oz. per ton; the *Main Reef*, 4 ft. to 40 ft., with gold up to 1 oz. per ton; and the *North Reef*, 1 ft. to 5 ft., with gold up to 1 oz. per ton. They run generally east and west, and dip less than 12° to the south; to the east they become more

broken up and turn towards the south. In the neighbourhood of Wonderfontein many caves have been worn out. The gold occurs in conglomerate beds, in ferruginous earthy deposits, and in fissures, usually in the matrix, and in a crystalline or scaly form, and is generally most abundant in the disturbed parts.

The De Kaap Valley, west of the Drakensberg, shows at the base disintegrated granite, with the overlying mudstones and quartzites sharply folded together; the latter form ridges along the mountain range, and are generally auriferous, especially at Sheba. There are also the auriferous conglomerates, and numerous trap dykes. In the Makongwa Range is a bed of black cherty quartz, which in places is rich in gold. The intrusions of the trap have caused surface fissures, which are filled with auriferous quartzose material, and the alluvial deposits also occasionally contain gold in the form of crystalline nuggets.

Under the title Zoutpansberg is given an account of the country north of Pretoria for 130 miles, and then east over the Drakensberg to the Murchison range. About 50 miles to the north commence flats with saline deposits containing 34—70 per cent. of carbonate of soda, and at 70 miles are warm springs. On either side of the Nylstroom are beds of the auriferous conglomerates, and further east the granite rises into isolated hills called Koppies. The Murchison and Paloboro hills are capped by the shales and mudstones. The coal beds lie to the south, midway between Pretoria and Barberton, and lie unconformably on the conglomerates. The thickest coal bed is 21 ft. The same deposits occur in the Piennar Ridge and Waterberg hills north of Pretoria, but yield no coal there. The analyses of the coal show 65—72 per cent. of carbon, 2—4 per cent. of sulphur, and 15—23 per cent. of ash. It does not produce a good coke. The only fossils are—*Lepidodendron*, *Pecopteris*, and *Neuropteris*.

The other mineral products of the district are—silver, copper, lead, tin ?, zinc, iron, mercury, cobalt, and nickel, &c.

***546. Penning, W. H.—A Contribution to the Geology of the Southern Transvaal.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 451, pl. xv.

This paper appears to be supplementary to one by the author in the Quart. Journ. Geol. Soc., vol. xli. (1885). He divides the rocks in ascending order into:—the De Kaap Valley beds, the Witwatersrand series, the Klip River series, the Kimberley beds, and the High Veldt beds.

The De Kaap Valley beds include the "Sheba Reef," and consist of schists, shales, and quartzites. He believes them, without fossil evidence—which is lacking throughout—to be Silurian.

The next two series he classes together as the Megaliesberg Formation, and considers Devonian. By observations of dip round the margin, he considers the Witwatersrand series to form a basin, 18,000 ft. deep in the centre, or 13,000 ft. below sea-level.[1] They are largely composed of conglomerates (*see* Nos. **737**, **741**, of 1890). The Klip River series is 18,000 ft. thick, and contains the "Black Reef."[2]

The upper series of rocks are classed as the "High Veldt Coal Formation," and are considered, on unstated grounds, to be Oolitic in age, other authors calling them Karoo beds, and classing them as Carboniferous to Triassic. They are unconformable on the lower series.

The absence of gold-bearing alluvium, which should have been produced by the denudation previous to the High Veldt formation, is considered to be due to that denudation having been glacial, which alone could carry off the gold, and there are evidences of glacial erosion 2,000 ft. lower 300 miles away. There was another fluviatile denudation in the early part of the High Veldt formation.

547. Newton, E. T.—Notes on the Geology of British Central Africa.

Proc. Zool. Soc. for 1891, p. 310.

A brief summary of the observations of Jas. Stewart (1881) and H. Drummond (1881) on the region near Lake Nyassa.

STRATIGRAPHICAL GEOLOGY—AMERICA.

***548. Jukes-Browne, A. J., and Harrison, J. B. —The Geology of Barbados. Part I. Coral Rocks.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 197, pl. ix.

The island is composed of coral rock, oceanic beds, and Scotland beds, and there is no trachyte, as stated by A. Agassiz. It is not volcanic, nor an area of subsidence, yet there are fringing reefs. Coral grows all round the island, except where muddy streams enter the sea. A typical submarine contour is as follows: 3 fathoms is reached at 500 yards, then comes a steep slope to 13 fathoms, then a plateau deepening to 24 fathoms, and then a steep slope to 100 fathoms. Where there are coral reefs, they grow on this plateau from 10 to 25 fathoms down. Where the upper coral reef reaches the surface at Cobblers' Reef, there is a submarine barrier reef at the extremity of the plateau rising from 23 to 9 fathoms and running parallel to the inner reef with a channel between, coral growth being prevented outside by the depth, and inside by the deposit of coral sand.

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[1] Other locally-informed speakers, at the reading of the paper, said the beds were too disturbed to afford a conclusion.

[2] Mr. Alford called this a "small local series."

We learn from this that coral growth may be 180 ft. thick, that coral *débris* from a lower level will differ only in the absence of large coral masses, and that the shelf-like appearance of the raised reefs may be an original feature.

The raised reefs rise to nearly 1,100 ft. in the centre of the island; the higher ones are in terraces round two centres, the lower ones encompass both; in one part there are at least 11 terraces, some with sea-worn caves. The thicknesses of the coral rock in various places is given, several being over 180 ft. up to 260 ft., the lower portion in these cases being coral *débris* only.

The coral rock is not oolitic, but is sometimes a soft free-stone, composed of coral fragments, or occasionally of nullipores; on the surface for a small thickness, it is often hardened by calcareous water, which rises under a tropical sun by capillary action, and evaporates. Shells are only preserved at the lower levels. Details of various exposures are then given, bearing out the above remarks. Near Fisher Pond, the rock is very like chalk rock, and at Ellis Castle, a compound coral was found 130 ft. from the top. Near Sheetes Bay, the coral rock is seen resting unconformably on the Oceanic and Scotland beds, which are themselves unconformable. In the north-east of the island, the coral rock forms a great escarpment formed in the early stages of the elevation, and below it, here and there, is a thinner slope of coral growth of a later date, and in one place there is an *Amphistegina* rock. The Christchurch ridge was originally formed round a separate island, now joined to the rest by elevation. Three varieties of coral rock are distinguished. 1. Reef-rock, composed solely of coral *débris* and coral sand. 2. Lagoon and channel deposits of looser original texture, and containing other organisms than corals. 3. Beach rocks of miscellaneous fragments.

The following analyses are given of various coral rocks:—

Calcium carbonate ..	95·78	93·38	99·01	98·09	98·80	97·26
Magnesium carbonate	2·01	2·05	·56	1·25	·87	2·44
Calcium phosphate ..	tr.	·05	·13	·07	tr.	tr.
Iron oxide and alumina	2·27	·78	·35	·27	·19	·17
Silica and clay ..	·05	3·10	·20	·48	·29	·13
	100·11	99·36	100·25	100·16	100·15	100·00

Also of a white mud (1) and a brown crystalline concretion (2):—

	(1)	(2)
Calcium carbonate	97·50	84·89
Magnesium carbonate	1·11	1·48
Calcium phosphate	·21	·04
Calcium oxide	·41	—
Iron and alumina	·05	2·24
Silica and clay	·91	9·48
Loss on ignition	·26	2·01
	100·45	100·14

The following species of mollusca have been determined by **E. A. Smith** :—

Lucina columbella.	Columbella mercatoria.
——— jamaicensis.	Cerithium atratum.
——— dentata.	——— litteratum.
——— costata.	——— eburneum.
Tellina ephippium.	Murex messorius.
——— decora.	Strombus gigas.
——— interrupta.	Cassis flammea.
Olivella jaspidea.	Sistrum nodulosum.
Mitra barbadensis.	Littorina ahena.
Cypræa spurca.	Leucogonia cingulifera and var. angularis.
Pollinices porcellania.	Hipponyx antiquatus.
Natica marocana.	Bulla striata.
Obeliscus dolobratus.	

These are all species found in the West Indies at the present time.

The corals determined by **J. W. Gregory** : *Stephanocœlia intersepta*, *Siderastræa galaxea*, *Madrepora cervicornis*, *Diploria cerebriformis*, *Orbicella cavernosa*, all living in the neighbouring sea. *Colpophyllia* and *Hydriophora* uncertain, and *Heliastræa barbadensis*, *H. crassilamellata*, *Cyphastræa costata*, and *Solenastræa Verhetti* described by Duncan. All the genera are Atlantic and show no evidence for the Miocene age of any of the rocks.

The authors then proceed to refer to published accounts of recent coral rocks on other West India islands, with a view of showing their similarity to Barbados in the matter of their recent elevation, which must have been general, and have included also the mainland of Central America. On restoring the previous physical geography, by a depression of perhaps 2,000 feet, North and South America would be separated, and Central America would be an archipelago in Pleistocene times. It was previous to this that any actual depression took place. The opening of the present isthmus would cause the Gulf Stream waters to pass through it, thus aiding the production of a glacial epoch in Britain, and accounting for the Antillean plants and gigantic tortoises found in the Galapagos islands.

Appendix I. By **W. Hill.**—On the Minute Structure of some Coral Limestones from Barbados.

There are four varieties:—I. Coral fragments in a calcareous mud, with no foraminifera, but many specimens of a nullipore—*Lithothamnion*. II. Particles of an already consolidated mud, in a more coarsely-granular matrix, with abundant *Lithothamnion*, and a few foraminifera. III. A variety of organic fragments in mud or calcite; *Amphistegina* is a prominent form of foraminifer. IV. Coral sand cemented by calcite. Besides these *Amphistegina* rock occurs, the species being *A. Lessonii*. The plate illustrates these rocks.

Appendix II. By **W. Hill.**—On the Structure of the White Limestone of Jamaica.

Two specimens are like Nos. II. and III. above, another contains *Orbitolites*, and one from Bermuda is an Oolite.

549. Crawford, J. — On the Geology of Nicaragua.

Rep. Brit. Assoc. for 1890, p. 812.

The country is divided geologically into five regions. The first, or western, contains much volcanic ash, shell beds, and deposits "like" glacial drift. It is the region of mud floods. The second, to the north-east, is of ordinary stratified rocks of many ages. The third is a band of gneiss, granite, slate, &c., of Archæan and Palæozoic ages, with metalliferous lodes and caves. The fourth is a repetition of the second, with many placer mines; and the fifth consists of alluvial flats and swamps.

STRATIGRAPHICAL GEOLOGY—OCEANIA.

***550. Lister, J. J.—Notes on the Geology of the Tonga Islands.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 590, pl. xxiii.

A map of part of the South Pacific shows that if a N.N.E. line be drawn through the volcanoes of the North Island of New Zealand, its continuation is marked by a series of volcanoes on the Kermadec Islands, then by a greater number on the Tonga Islands, and finally leads to the largest volcano of the Samoa Islands. Thus the Tonga Islands lie in the course of a *line* of volcanic activity, which is also marked by a broader and more continuous band of shallows.

Seven of the Tonga Islands are marked as volcanoes. They all lie along the western boundary of the group. Five of them have been active during this century. The latest—the Falcon Island—is described in No. **45,** 1890. Savaii, in the Samoas, is at the crossing of the Tonga line with one at right angles to it.

Five islands, forming, with others, the Hapai group, lying in the centre of the east side, as also Eua to the extreme south, are of volcanic ash. One of these—Mango—contains agglomerate in one part, and elsewhere stratified tuffs of various coarseness. There is no old raised reef on it, though a large part of the fragments are coralline. It was formed below water, broke through a coral reef, and was elevated rapidly. In another—Tonumeia—a 2-in. manganese nodule was found, yet the coral fragments associated prove shallow water. Eua consists of a basis of volcanic ash running north and south, rising to a crest 1,000 ft. high, and extending

for 10 miles in length. The material is arranged in strata, some of which are calcareous, and contain organisms of pelagic type. In one place in these rocks there is a remarkable swallow hole, several hundred feet deep, called "Smoky hole." It has been produced in a water-worn crack. The eastern slopes are much more precipitous than the western, and the strata are nearly horizontal. Hence he concludes that the mass has been subjected to subaerial denudation.[1] It is now, however, covered with terraces of limestone. Hence it must have been up and then down. On the eastern shore are augite and hypersthene andesite dykes, and a boulder was found of "uralitised gabbro." This is called a plutonic rock.[2]

The limestone terraces are at various heights, the most constant from 250—315 ft. up. In one the margin is 65 ft. higher than the interior, showing a raised barrier reef, but the rock contains very little coral, only molluscs, echinoderms, polyzoa, algæ, and named foraminifera, which indicate shallow water, between 30 and 100 fathoms. The terraced form shows the intermittent elevation; the last terrace is only 7 ft. above sea-level.

The limestone islands form the largest and farthest extended part of the whole group on the eastern side. The most northern, Vavau, has cliffs 500 ft. high on the north-east, and forms two lower terraces towards the south-west, all being very flat topped. One isolated island, however, has an elevated marginal ring and broad depression in the centre, *i.e.*, it is a raised atoll. The islands in the Hapaii group are low, and form parts of a half-submerged barrier reef. Nomuka is another raised atoll, with the lagoon nearly dried up, and its bottom only 9 fathoms above that of the surrounding sea. Tongatabu, at the extreme south, is the largest, and is highest on the south-east.[3] It is nowhere high, and has a broken lagoon in the centre. On the south-eastern side are a series of basins, one above the other, with the edges of growing nullipore, which flourish in the breakers.

VERTEBRATE PALÆONTOLOGY.

551. Crawford, J.—Human Footprints in recent Volcanic Mud in Nicaragua.

Rep. Brit. Assoc. for 1890, p. 812.

[1] Would not marine currents do it?

[2] This would be a remarkable discovery, but much stress cannot, perhaps, be laid on a boulder of a possible dyke not seen *in situ*.

[3] All seem to be highest in the east; perhaps only those that are so have been able to withstand the waves.

The paper gives some details as to the footprints of men and wild and domestic animals on a bed of volcanic mud, now hardened, near Lake Managua, to which they were evidently hastening. The beds, for at least 10 ft. below, are of recent date, the "aluvion de Barro," in 1876, having covered the Plaza grounds with 5½ feet of mud, and filled up a low level street to a depth of 3 ft.

552. Marsh, O. C.—On the Cretaceous Mammals of North America.

Rep. Brit. Assoc. for 1890, p. 853.

Mammalia have only recently (1889) been found in Cretaceous rocks at all. They have now been met with, all of small size, in the Laramie formation. They belong to the group called by the author the *Allotheria*, which is represented by several types in Triassic and Jurassic rocks, and the new genera show close affinities with these, one being at present indistinguishable from *Dryolestes*.

There are also several genera of small marsupials, allied to the American Tertiary and recent forms. The ancestors, however, of the carnivores, rodents, and ungulates do not seem to be at all represented. The fauna, on the whole, is consonant with what might be expected from its stratigraphical position, but is more allied to the older forms than would have been anticipated. Some may be allied to Monotremes, as one at least had a free coracoid.

553. Panton, J. H.—The Mastodon and Mammoth in Ontario, Canada.

Geol. Mag., Dec. 3, vol. viii., p. 504. Abstract of paper read at the Brit. Assoc. in Aug., 1891.

The Mastodon is from a Marl bed near Highgate, Ontario, and measurements of its bones are given, by which it is seen to be larger that the Newburgh specimen, one of the finest ever discovered in America. The Mammoth is from Shelburne, Ontario, and has a tusk 12 ft. 8 in. and more.

***554. R. L[ydekker].—The Giraffe and its Allies.**

"Nature," vol. xliv., p. 524.

The extinct genus nearest to the living giraffe is the *Vishnutherium* from Burmah, which was a larger animal, but was nearest to the giraffe in the length of its metatarsus and in its cervical vertebræ. Next comes the *Helladotherium* from Greece, also larger, but shorter and stouter in the neck and limbs. The *Alcicephalus*, from the Persian Pliocene, connects this with the elk, having front and hind limbs nearly equal. The above do not show the unossified vacuity in front of the eye, and all have been probably derived from an ally of the Miocene *Jelocus*.

Sivatherium, *Bramatherium*, and *Hydaspitherium* have molar teeth like the giraffe, their humerus has the same double bicipital groove, and the terminal phalangeals of their feet are giraffe-like, hence it is argued that they are greatly modified giraffoids whose cranial appendages have been derived by special modification.

The *Samotherium*, from the Pliocene of Samos, whose teeth and shape of skull are giraffe-like, have an independently-acquired superficial resemblance to certain antelopes.

555. Forsyth-Major, C. J.—On the Fossil Remains of Species of the Family *Giraffidæ*.

Proc. Zool. Soc. for 1891, p. 315.

A review of the fossil allies of the Giraffe. Some, particularly *G. sivalensis*, appear to belong to *Giraffa* itself. The *Samotherium* described by the author in the Comptes Rendus in 1888, has horns in the male immediately over the orbits, while the female has none, except in aged animals, which have a pair of more central burrs. A figure is given of the skull of *S. Boissieri* in the British Museum. *Palæotragus*, from the Miocene of Pikermi, agrees with the giraffes in the wide interval between the orbits, and thereby between the horns. In *Sivatherium* and *Hydaspitherium* the horns arise from the parietals, as well as from the frontals, as is the case with the Giraffidæ. The *Helladotherium* is distinct from *Sivatherium*, and presents a homologue of the median protuberance of the Giraffe.

***556. Seeley, H. G.—On *Bubalus Bainii* (Seeley).**

Geol. Mag., Dec. 3, vol viii., p. 199.

This is represented by a cranium with horns, now hanging in the South African Museum at Cape Town, and referred to by Mr. Bain in 1839 in the Proc. Geol. Soc. as having been obtained from the alluvium of the Moddar, a tributary of the Orange River. Of this the present author gives a figure, and calls it by the above name. The horns make a large curve, with the concavity behind. From tip to tip the distance is 8 ft. 6½ in., and measured round the concave curve extend a length of 11 ft. 6 in. in all. They are very slightly flattened. The head is 22½ in. or more in length, and narrow from side to side. This bears the same relation to the modern South African buffalo that *Bos primigenius* does to the modern English ox.

***557. Lydekker, R.—On a Cervine Jaw from Algeria.**

Proc. Zool. Soc. for 1890, p. 602.

This is from a probably Pleistocene tufa near Guelma. It shows three molars and two premolars, representing "the most complex type of brachydont and selenodent molars yet described." It is called *Cervus algericus*, and is defined as fol-

lows:—"Somewhat smaller in size than *C. cashmirianus*, with brachydont molars, having a very large inner cingulum, and the external surface complicated by the excessive development and reflection of the lateral ridges of the outer crescents, so as to form distinct pockets on the surface at the base of the ridges in question."

***558. Cooke, J. H.—Notes on *Stereodon melitensis*, Owen.**

Geol. Mag., Dec. 3, vol. viii., p. 546.

Owen described the jaws only, but referred to a specimen not sent to him, as showing the vertebral column. This shows that the vertebræ are round and biconcave. Their transverse diameters are longer than their antero-posterior axis. and above and below are backwardly-directed spines, anchylosed to the neural and hæmal arches, and flattened longitudinally.

***559. Lydekker, R.—On Lower Jaws of Procoptodon.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 571, pl. xxi.

This is the description of some mandibular rami of Kangaroo-like animals referable to *Procoptodon*. One, which is deeper and shorter, he refers to *P. rapha*, and the other, longer and narrower, to *P. Goliah*, but he notes that the types of these two species are not very clearly defined. The plate shows the mandibles.

***560. Lydekker, R.—On the Generic Identity of *Sceparnodon* and *Phascolonus*.**

Proc. Roy. Soc., vol. xlix., p. 60, pl. i.

Phascolonus was described from cheek-teeth, *Sceparnodon* from incisors, but no incisors of the first, and no cheek-teeth of the last are known. Specimens of the incisors agree in colour and small details with the cheek-teeth in the British Museum collections, and now that a large series has been brought from Bingera, New South Wales, there is still the same similarity and mutual exclusion of the kinds of teeth. The conclusion is that the incisors described as *Sceparnodon* are those of *Phascolonus*. The plate figures a mandible and upper incisor.

***561. Lydekker, R. — On Pleistocene Bird-Remains from the Sardinian and Corsican Islands.**

Proc. Zool. Soc. for 1891, p. 467, with pl. xxxvii.

These remains are from a cave at Pietro Tampoia, in the island of Tavolara, north-east of Sardinia, and from breccias near Iglesias, and at Toga, near Bastra, Corsica. An African species of *Bubo*, and a Roller are present, but no differences can be found to indicate extinct forms. All the remains are of limb bones. The species which they are referred to or compared with are *Bubo* cf. *cinerascens*, Gm.; *Milvus* cf. *ictinus*, Sav.;

Aquila sp.; *Vultur* cf. *monachus*, L.; *Coracias* cf. *abyssinica*, Bodd.; *Corvus corone*, L.; *Fringillidæ; Alaudidæ; Sylviidæ; Turdidæ; Hirundinidæ* spp.; *Columba* cf. *livia*, L.; *Coturnix communis*, Bonn.; and *Procellaria* sp.

***562. Lydekker, R.—On Remains of a large Stork from the Allier Miocene.**

Proc. Zool. Soc. for 1891, p. 476.

The name *Pelargopsis*, used for the remains of one of the known forms, is preoccupied by Gloger for a genus *Alcedinidæ*, so he proposes instead the name *Pelargodes*. The author has recently examined in the British Museum a right coracoid and a metacarpus from the same district, which agree in contour with those of *Ciconia alba*, but as they are larger in size, he considers it probable that they belong to *Propelargus*, and as there is no proof that they are of the same species as that from the phosphorites, as he provisionally suggested, he prefers to give them the new name of *P. Edwardsii*. Two woodcuts are given.

***563. Lydekker, R.—On a New Species of Moa.**

Proc. Zool. Soc. for 1891, p. 479, with plate xxxviii.

The remains on which this species is founded are: a tibiotarsus with the outward curvature of the shaft, and marked inflection of the distal extremity, characteristic of *Pachyornis*, but differing from that of *P. elephantopus* by the slenderer proportions; the tarso-metatarsus, which is also similar, but slenderer, and with the distal trochleæ more expanded; the femur, which agrees also in the contour and dimensions of the popliteal depression and in the form of the linea aspera, but the distal width of the femur is smaller in proportion to its length, approaching the relative proportions in *Dinornis maximus*. He therefore refers the bones to a new species called *P. Rothschildi*.

***564. Lydekker, R.—On a New Species of *Trionyx* from the Miocene of Malta, and a Chelonian Scapula from the London Clay.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 37.

The Maltese specimen is a fragment of carapace from the buff limestone. The position of the shorter lateral surfaces of the neural bones shows that it is the anterior part, and there are two neural bones between the first pair of costals, a character confined to Indian species of *Trionyx*. It shows the coarse sculpture of *Chitra indica*, but in this genus a divided first neural is unknown. He therefore calls the species *Trionyx melitensis*, and remarks on its Indian affinities.

***565. Boulenger, G. A.—On some Chelonian Remains preserved in the Museum of the Royal College of Surgeons.**

Proc. Zool. Soc. for 1891, p. 4.

The first is the skull of a land tortoise, presumably a

fossil from Mauritius. It is allied to *Testudo triserrata*, Gthr., by the possession of two median ridges on the alveolar surface of the maxillary, but differs from it in the small tympanum, whose greatest (vertical) diameter is only about ⅜ that of the orbit. The vomer is also produced so far back as to form a suture with the basisphenoid. He names it *T. microtympanum* and gives woodcuts.

***566. Woodward, A. S.—Note on a Tooth of an Extinct Alligator** *Bottosaurus belgicus* **(sp. nov.), from the Lower Danian of Ciply, Belgium.**

Geol. Mag., Dec. 3, vol. vii., p. 114.

Such is the provisional name assigned to a tricuspid tooth without a fang. It is about twice as long, as broad or high, is covered with dense dark enamel, has no longitudinal keel, and is nearly smooth. "There being apparently no piscine dentition to which such a tooth can be compared," he calls to mind its resemblance to the tooth called *Bottosaurus Harlani* from the New Jersey Greensand, and names it accordingly.[1]

***567. Seeley, H. G.—On** *Agrosaurus Macgillivrayi* **(Seeley), a Saurischian Reptile from the N.E. Coast of Australia.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 164.

This describes some limb bones, principally a left tibia, supposed to have been collected by Macgillivray, and which had long been placed in the Mammal Gallery of the British Museum. The tibia has a much enlarged triangular proximal end, with two areas for the articulation of the femoral condyles. The middle of the shaft is slender and ovate in section, the distal end expanded and quadrangular, and with a deep notch on its articular surface, separating a broad talon-like area. There are two claws like those of carnivorous reptiles. He considers it allied to *Dimodosaurus* and *Massospondylus*, but to be defined generically "by its slender shaft, by the enlarged proximal end which curves backward, by the slight development of the cnemial crest, by the uniform increase in size of the distal end, and by the moderate excavation of the distal articulation on the inner side."

***568. Boulenger, G. A.—On a Stegosaurian Dinosaur from the Trias of Lombardy.**

Ann. Nat. Hist., ser vi., vol. viii., p. 292.

A cast of an unknown reptile foot from Esino, preserved in the College of Surgeons. The original is said to be at Milan. It is a foot allied to that of *Scelidosaurus*, but with a fifth toe perfectly developed, the digits more slender, and the distal phalanges broader. He *names* it *Eupodosaurus longobardicus*, and asks for further information about the original.

[1] Modern alligators have no tricuspid teeth.

569. Marsh, O. C.—Restoration of *Stegosaurus.*

Geol. Mag., Dec. 3, vol. viii., p. 385, pl. xi.

The plate is reduced from a larger drawing prepared for a monograph on the *Stegosauria* for the U.S. Geological Survey. This animal had a length of 20 ft., and was 12 ft. high. It was probably able to stand on its hind limbs and tail. The small elongated skull was covered in front by a horny beak. The small teeth, with compressed fluted crowns, indicating a succulent vegetable diet, are confined to the maxillary and dentary bones. The vertebræ are flat or biconcave, and, like all the other bones, are solid. The ribs are placed high above the centra, and articulate by the tubercle alone. The summits of the neural arches are expanded for the support of the dermal spines. The feet were short and massive, and the toes, five in the fore-feet, three and a rudimentary fourth in the hind feet, were terminated by hoofs. The throat was covered by a thick skin with embedded ossicles. There were two plates protecting the neck at the back of the skull. The large dermal spines were covered with horn, as evidenced by their vascular grooves, and the four pairs of flat spines above the tail are a specific character. The animal occurs in the Upper Jurassic of Wyoming [fig. 3].

570. Marsh, O. C.—The Gigantic Ceratopsidæ, or Horned Dinosaurs of North America. Part II.

Geol. Mag., Dec. 3, vol. viii., pp. 193, 241, 248, pls. iv. and v. and vii.

Abstract in Rep. Brit. Assoc. for 1890, p. 793.

This is a summary of recent additions to knowledge, the full account of which will appear in the Reports of the United States Geological Survey, and some have been already published in the *American Journal of Science*. The remains come from the Laramie formation. The skull already described [*see* No. **692,** 1890] had the pointed rostral bone free; in another it is co-ossified to the skull. The horn cores are hollow at the base. There is a parietal or pineal foramen between the frontals and parietals. There is an expanded parietal crest, with marginal armatures. The brain is smaller in proportion to the skull than in any known vertebrate, and its axis runs at an angle of 30° with that of the skull—a figure is given showing a large pituitary body. The teeth form a single series in each jaw, confined to the maxillary and dentary bones, and all are similar in shape. Each had two fangs, but these are arranged transversely, and the teeth are not displaced vertically by their successors, but from the side. The atlas, axis, and at least one other vertebra are co-ossified. The cup for the occipital condyle is nearly round, and very deep. The diapophyses of the posterior trunk-vertebræ have faces for both the head and tubercle of

the ribs. The sacrum was originally of four vertebræ, whose processes were united at the ends to each other and to the ilium, and there are now two anterior, once lumbar, vertebræ, of which there are none besides, and four posterior, once caudal, joined to the central four, producing a very avian sacrum. The tail was of moderate length. The scapula and fore limb were massive, and there were five hoof-like digits. All the bones of the pelvis take a part in forming the acetabulum. The ilium is much elongated before and behind. The ischia did not meet at their distal ends. The hind limb is massive and the digits [three by the figure] were terminated by very strong hoofs. All the limb bones and vertebræ are solid. There were several spines, bosses, and plates in the dermal armour, but their position cannot be fixed. In the appendix a restoration of the animal, which was 25 ft. long and 10 ft. in height, is given [fig. 4]. The species which he previously called *Triceratops flabellatus* is now made the type of a new genus called *Sterrholophus*. They were all herbivorous.

***571. Seeley, H. G.—Researches on the Structure, Organisation and Classification of the Fossil Reptilia. VII. Further Observations on *Pareiasaurus*.**

Proc. Roy. Soc., vol. xlix., p. 518.

An abstract only is here given. Five zones of life can be distinguished in the Karoo Beds, viz., commencing at the bottom (?), the Mesosaurian, Pareiasaurian, Dicynodont, Theriodont and Zanclodont zones. Two skeletons and a jaw of *Pareiasaurus* have been found.

The shoulder girdle is more Labyrinthodont than was previously supposed, the skull is more Reptilian, the pelvis and limbs more Mammalian, though with some resemblance to Dinosaurs. The *Anomodontia* are thus classed :—

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                  Theriodontia.
                 /      |      \
     Placodontia.       |       Dicynodontia.
       |      \         |        /      |
       |       Endothiodontia.          |
       |      /                  \      |
     Pareiasauria.                Mesosauria.
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572. Dawson, Sir J. W.—On New Specimens of *Dendrerpeton acadianum*, with Remarks on other Carboniferous Amphibians.

Geol. Mag., Dec. 3, vol. viii., p. 145.

The author takes the opportunity of the discovery of some fresh specimens of the above-named species, in the same locality and circumstances as the original, to give a complete description of the animal, as far as known. It was probably elongated and lizard-like, with a broad flat head, short stout limbs, the hind no larger than the fore, and an elongated

tail; the underside of the body with overlapping bony plates, the upper with a tough scaly skin.

The remainder of the paper deals with *Hylonomus Lyelli*, of which no new remains have been found, but which he is led to discuss in connection with the above. This animal with others often associated make the group *Microsauria*, which are not Labyrinthodonts properly so called, but make a nearer approach to Reptiles. On this account he gives a detailed description of the remains. Its body was flattened from side to side; its skull was 1 in. long, and the whole body and tail about 6 in.; the bones are smooth, dense, and thin; the brain case was rounded and there was a parietal foramen. The teeth are anchylosed to the jaw or lie in a partial groove; they are numerous and simple. The vertebræ are biconcave, and are hollow within, being only superficially ossified. The neural arches are anchylosed to the bodies, the dorsal vertebræ had strong lateral diapophyses for the articulation of the ribs, which are curved and have a neck and shoulder. The hind limb was stronger than the fore, and attached to a large and broad pelvis. It is uncertain whether there were more sacral vertebræ than one. The femur had a distinct head and the tibia and fibula were much shorter than it. These bones have large internal cavities. The dermal covering is of bony scales below and finer scales above. He notes that Credner (Z.D.G.G., 1890) is of the same opinion as to the intermediate position of these animals.

573. Dawson, Sir J. W.—Note on *Hylonomus Lyelli*, with Photographic Reproduction of the Skeleton.

Geol. Mag., Dec. 3, vol. viii., p. 258, pl. viii.

This is a figure of the originally described specimen in the Museum of the Geological Society. It shows some caudal vertebræ.

***574. Boulenger, G. A.—On the Occurrence of *Discoglossus* in the Lower Miocene of Germany.**

Ann. Nat. Hist., ser. vi., vol. viii., p. 83.

The author has accidentally observed in the Geological galleries of the British Museum a fossil frog, labelled *Rana Merianæ*, which is really a Discoglossoid, as indicated "by the arciferous pectoral arch, the impressions of opisthocœlous vertebræ, and the presence of transverse processes to the coccygeal style," and by a characteristic rib to the fourth vertebra. In proportions, shape of fronto-parietals, size of nasals, feeble expansion of the sacral transverse processes, length of coccygeal style and short web, it agrees with *Discoglossus pictus*. It also agrees with the so-called "*Alytes*" *Troschelii* from the same deposits, and ought, therefore, to be called *Discoglossus Troschelii*.

***575. Woodward, A. S.—Remarks on the Miocene Fish Fauna of Sardinia.**

Geol. Mag., Dec. 3, vol. viii., p. 465. Abstract of paper read at the Brit. Assoc., Aug., 1891.

Merely mentions the names of some fishes found near Cagliari, besides those recognised by Bassani.

***576. Woodward, A. S.—Notes on some Fish Remains from the Lower Tertiary and Upper Cretaceous of Belgium, collected by Monsieur A. Houzeau de Lehaie.**

Geol. Mag., Dec. 3, vol. viii., p. 104, pl. iii.

The following species are described from the Eocene, those figured being marked by an asterisk:—A crushing tooth of **Cestracion Duponti*, Winkler; teeth of *Odontaspis elegans* (Ag.); *Oxyrhina nova*, Winkler; *O. Desori*, Ag.; *Lamna* **verticalis*, Ag.; this, *pace* L. Agassiz, he has not been able to identify in any British Eocene deposit; *L. Vincenti* (Winkler); *Ginglystoma thielense* (Winkler); *Scymnus trituratus* (Winkler); *Squatina*, sp.; *Cœlorhynchus rectus*, Ag.; *Lepidosteus*, sp.; **Pisodus Oweni*, Owen; *Ancistrodon fissuratus* (Winkler); *Phyllodus*, sp.: *Cybrum?* sp.; *Sargus*, sp.; **Trigonodon serratus* (Gervais). Other, elsewhere described, species bring the total to 31.

From the Danian of Ciply the following are described:—*Scapanorhynchus rhaphiodon* (Ag.). In relation to this he notes that the teeth called *Odontaspis elegans* belong to this genus, and though the Chalk forms bear much resemblance to Tertiary species, they are insufficient to establish the range of a shark from the Danian to the Lower Miocene [*cf.* No. **701,** 1890]. *Odontaspis Bronni*, Ag.; this also closely resembles a Lower Eocene form; *O. Houzeaui*, sp. nov., teeth slender, sharply pointed, outer coronal face flattened, with numerous wrinkles on the base line, the inner face smooth, a single pair of denticles, anterior teeth more sigmoidally curved, and internal bulging of root very prominent; *Lamna crassa* (Ag.); *Corax pristodontus*, Ag.; 14 associated teeth; *Elasmodus Greenoughi*, Ag.; *Acrotemnus subclavatus* (Ag.); the total number known is 15.

577. Woodward, A. S.—On some Upper Cretaceous Fishes of the Family** ***Aspidorhynchidæ.

Proc. Zool. Soc. for 1890, p. 629, pls. liv., lv.

A very detailed description of a fish, hitherto called *Aspidorhynchus Comptoni*, is given, and it is pointed out that "the suborbital ring is in direct contact with the preoperculum throughout its length, there being no supplementary cheek plate, such as characterises *Aspidorhynchus*, and only two series of flank scales are deepened—one excessively so." These being special characters of *Belonostomus*, he refers the

fish to that genus, but as it is specifically distinct from other species of the genus, he retains the specific name of *Comptoni.*

The fish from Mount Lebanon, previously called *Belonostomus laniatus*, which is described in detail, is referred to a new genus, *Apateopholis*, which is thus defined. Body much laterally compressed; head relatively large; mandible equalling the snout in length teeth mostly small, conical, but there is a single series of well-spaced lanaries in the front half of the mandible. Preoperculum deep, triangular, with a long, robust, posteriorly - directed spine at its postero-inferior angle: vertebræ well ossified; ribs robust; dorsal fin as long as deep, in front of the anal, which is remote, elongated, and relatively low; caudal fin deeply cleft; scales very thin and feebly ornamented, a single series of deep scales occupying the greater part of the flank.

***578. Woodward, A. S.—On the Discovery of a Jurassic Fish Fauna in the Hawkesbury Wianamatta Beds of New South Wales.**

Rep. Brit. Assoc. for 1890, p. 822.

These consists of species of *Coccolepis*, only known in European Jurassic deposits, of two new genera allied respectively to *Semionotus* and the Dapedioids, the latter with typical rhombic ganoid scales in the front half of the trunk, and overlapping cycloid scales behind; of *Leptolepis* and a new allied genus. They are to be described in the Australian Memoirs.

579. Fritsch, A.—Restorations of the Palæozoic Elasmobranch Genera *Pleuracanthus* and *Xenacanthus*.

Rep. Brit. Assoc. for 1890, p. 822.

An exhibition of plates of a new volume shortly to be published.

The genera prove to be true Selachians.

***580. Woodward, A. S.—The Devonian Fish-Fauna of Spitzbergen.**

Ann. Nat. Hist., ser. vi., vol. viii., p. 1, pls. i.—iii.

This is a further description of fishes brought by Baron Nordenskiold several years ago, and partially described by Ray Lankester.

The strata are divisible into two groups.

From the Lower Devonian are described *Pteraspis Nathorsti*, Lank.; *Acanthaspis decipiens*, sp. nov.; *A. minor*, sp. nov.; *Lophostracon Spitzbergense*, Lank.; *Porolepis*, gen. nov., with scales having no peg-and-socket articulation; the exposed surface covered with punctate ganoine, and in the front part marked with oblique wrinkles; *P. posnaniensis* (Kade);

From the Upper Devonian are described, *Psammosteus*

arenatus, Ag. (also British); *Asteroplax*, gen. nov., with cranial roof-bones richly ornamented with coarse rounded tubercles, more or less fused into ridges; *A. scabra*, sp. nov.; *Onychodus arcticus*, A.S.W.

INVERTEBRATE PALÆONTOLOGY.

*581. Foord, A. H.—On *Orthoceras vaginatum*, Schlotheim.

Geol. Mag., Dec. 3, vol. viii., p. 355.

This deals with a point of nomenclature. The author had referred a "smooth" species of *Endoceras* from Reval to *O. vaginatum*, Schl., and it is now stated by Dr. Dames that Schlotheim's type is a transversely-ribbed form. He consents, therefore, to call the smooth species by the next name on the synonymy, viz., *E. Zaddachi.*[1]

*582. Waters, A. W.—North Italian Bryozoa.

Q. J. Geol. Soc., vol. xlvii., p. 1, plates i.—iv.

The fossils here described are from the Vicentine Tertiaries, and the greater number have been described by Reuss. He recommends soaking the specimens in sodic sulphate, and washing this away after crystallisation. Many of the species occur both in the encrusting and in the erect form. The following are the species described and figured:—? *Catenaria tenerrima* (Rss.), *Catenicella septentrionalis* (sp. nov.), *C. continua* (sp. nov.), *Scrupocellaria elliptica* (Rss.); this is not the same as the British fossil referred to it by Hincks, which should stand as *S. inermis*, Norm.; *S. gracilis*, Rss., *S. Brendolensis* (sp. nov.), *S. Montecchiensis* (sp. nov.); *Bactridium Hagenowi*, Rss.; *Cellaria Reussi*, D'Orb. Remarks are then made on the genus *Onychochella* of Julien, characterised by its large vicarious avicularia, the mandible of which is attached to the membraneous cover and there is no crossbar. *O. angulosa* (Reuss) occurs in both incrusting and in the vincularia stage. *Vibracella* is a new genus with moderately large opesial openings, and vicarious eared vibracular cells. *V. trapezoidea* (Rss.) is both incrusting and free. *Membranipora macrostoma* (Rss.), *M. tenuirostris*, Hincks; *M. Dumerilii* (And.); *M. Rosselii* (And.); *M. patellaria* (Moll.); *M. appendiculata* (Rss.); *M. Hookeri*, Haime; *M. coriacea*, Esper; *Micropora polysticha* (Rss.); *M. parallela* (Rss.); *M. articulata* (sp. nov.); *M. cucullata* (Rss.), erect and incrusting; *Cribrilina radiata* (Moll.); *C. Chelys*, Kosch.; *C. crenatimargo* (Rss.); *Monoporella sparsi-*

[1] Schlotheim's description was unintelligible to Lindström and to Hisinger, who called the same thing *O. trochleare*, and he refers to a figure of Breyn's representing a smooth species. Query.—If an author describes a black specimen as white, is the "type" white or black?

pora (Rss.); *Lepralia subchartacea* (d'Arch.); *L. semilævis* (Rss.); *L. bisulca* (Rss.); *L. nodulifera* (Rss.); *L. impressa* (Rss.); *L. excentrica* (Rss.); *L.? syringopora* (Rss.); *L.? bericensis* (sp. nov.); L.? lontensis (sp. nov.); *Smittia coccinea* (Abild.) and var. *alifera; S. Landosbrovii* (Johnst.) var. *cheilopora*; *S. porrigens* (Rss.); *S. exarata* (Rss.), *Porella imbricata* (Rss.); *P. marsupium*; MacG., var. *porifera; Rhamphostomella brendolensis* (sp. nov.); *Porina ? coronata* (Rss.). This and *Lepralia syringopora* have a closure, in the form of a calcareous disc with a tubule rising in the middle, which was hitherto supposed to be confined to the *Cyclostomata*; *P.? duplicata* (Rss.); *P. ? papillosa* (Rss.); *P. ? bisculata*, sp. nov.; *Schizoporella Hoernesi* (Rss.); *S. squamoidea* (Rss.); *S. unicornis* (Johnst.); *S. serrulata* (Rss.); *S. Omboni* (Gott.); *S. phymatopora* (Rss.); *S. Schreibersi* (Rss.); *S. ternata* (Rss.); *Fedora excelsa* (Kos.), which grows from the apex of the colony; *Retepora tuberculata*, Rss.; *R. elegans*, Rss.; *Cellepora proteiformis*, Rss.; *C. oligostigma*, Rss.; *C. pertusa*, Smitt.; *Stichoporina simplex*, Kos.; *Batopora multiradiata*, Rss., with a diagram showing the large apical cell; *B. Stoliczkai*, Rss.; *Lunulitis quadrata*, Rss. Of these 66 species, 12 are still living.

583. Nicholson, H. A.—On some New or Imperfectly Known Species of Stromatoporoids, Part IV.

Ann. Nat. Hist., ser. vi., vol. vii., p. 309, pls. viii—x.

All the species but one here described are American, mostly Canadian. They are *Stromatopora antiqua*, N. & M. (also British); *S. hudsonica*, Dawson (also British); *S. Carteri*, Nich. (also British); *S. borealis*, sp. nov., differs from the last in the cænosteum being laminar instead of massive, and in the extensive development of the astrorhizæ, from Oesel; *Actinostroma expansum*, Hall and Whitf.,; *A. Tyrrellii*, sp. nov., differs from the British *A. stellulatum* in having the "arms" of the radial pillars better developed in the closeness of the "concentric laminæ," and the less development of the astrorhizal canals; *A. Whiteavesii*, sp. nov., with a fine skeletal structure, exceptionally thick and regular connecting processes of the radial pillars, and the astrorhizæ reduced to radiating rosettes, without any branches; *A. matutinum*, sp. nov., without astrorhizæ, and with thick radial pillars and strong close set undulating concentric laminæ; *A. fenestratum* Nich. (also British); *Syringostroma ristigorichense*, Spencer (also British); *S. nodulatum*, Nich.; *S. densum*, Nich. (also British). The British species, *Clathrodictyum variolare* (Ros.), also occurs in Canada.

***584. Hinde, G. J.—Notes on a new Fossil Sponge from the Utica Shale Formation (Ordovician) at Ottawa, Canada.**

Geol. Mag., n.s., Dec. 3, vol. viii., p. 22.

These organisms appear as overlapping patches of radiating spicules on a flat surface. These are very fine, straight, smooth, and not all of the same length, so that the boundary is irregular. The average diameter of the circular patches is 18—24 mm., but they are sometimes fan-shaped, and sometimes leave a free space in the centre. The spicules are now mostly made of pyrites or rusty peroxide, but were doubtless originally siliceous. They resemble most the basal spicules of *Radiella*, but it is not clear whether they belong to a monactinellid or hexactinellid sponge, whose basal supports they doubtless were. He names them *Stephanella sancta*, and gives a woodcut.

***585. Hinde, G. J.—Notes on Specimens of Cherty Siliceous Rock from South Australia.**

Geol. Mag., Dec. 3, vol. viii., p. 115.

The specimen contains numerous negative casts of fossils in a matrix showing sand-grains, and principally sponge-spicules, which have been dissolved and redeposited as globular opal. The rock is probably Tertiary.

586. Gregory, J. W.—The Tudor Specimen of Eozoon.

Quart. Journ. Geol. Soc., vol. xlvii., p. 348.

This specimen has now been examined in section and microscropically. The rock is a calc mica schist with obscure bedding-planes. The cleavage is due to the development of white mica plates,[1] and there is abundance of graphite. The cleavage is parallel to the surface of the slab and crosses the bedding obliquely. The white calcite bands, which are called *Eozoon*, are veins of crystalline calcite seldom more than $\frac{1}{10}$-in. deep, they are connected with others along the cleavage, and neither proper walls nor canals can be recognised,—the latter, so-called, being carbonaceous inclusions. The calcite bands do not partake in the cleavage and crumpling, and must therefore be secondary. The bedding planes are even seen in the matrix between the bands, *i.e.*, in the supposed body chambers.

The explanation that these are calcite infiltrations along cracks is disproved by there being patches of the schist entirely surrounded by the calcite,[2] and the junctions are moreover irregular. "It seems more probable that the calcite bands were formed by the solution of the limestone and its redeposition along the lines on which the water percolated through the rock." Where the calc mica schist protrudes, the calcite is in crystalline continuity, its cleavage planes [*i.e.*, of the mineral, not of the rock] pass from one to

[1] Or is the mica due to the cleavage?

[2] Yet horses are found in mineral veins.

the other. The rock itself belongs to the Grenville series now classed with the Huronian. The calcite bands have only been developed on the weathered surface of the slab. The conclusion is that the whole is inorganic and of secondary origin.

MINERALOGY.

587. Kunz, G. F.—(1). Tysonite and Bastnäsite. (2). Meteoric Iron from Indian Valley Township, Virginia. (3). Anatase. (4). Sapphire.

Miner. Mag., vol ix., No. 14, p. 394.

(1). A large mass of Tysonite covered with Bastnäsite, weighing 6 kil., has been found at Crystal Park, near Mainton Springs, Colorado. Both show absorption spectra and uniaxial figures, and the latter may be only a variety of the former.

(2). This meteoric mass weighs 14 kil. It is cubic iron which shows figures on etching. Its analysis by **A. G. Eakins** gave Iron 93·59, Nickel 5·56, Cobalt ·53, Phosphorus ·27, Sulphur ·01 = 99·96.

(3). Notes some crystals of Anatase on Quartz near Placerville, Eldorado County, California.

(4). The sapphires of the Northern Missouri River, near Helena, Montana, vary in colour, but never show the true blue, or ruby-red. At Ruby Bar (so called from the red garnets) the sapphires occur in an eruptive vein of vesicular mica-augite-andesite cutting green slate.

588. Foote, A. E.—A New Locality for Meteoric Iron, with a Preliminary Notice of the Discovery of Diamonds in the Iron.

"Nature," vol., xlv..p. 178.

Masses of meteoric iron have been found in Cañon Diablo, Arizona, the largest weighing 201 lbs., which, when one was cut by emery, destroyed the wheel, and it was found that little black diamonds studded the mass, with granules of amorphous carbon. Nickel is present to about 3 per cent.

589. Anon.

"Colliery Guardian," vol. lxi., p. 749.

At Black Lake, Quebec, scolecite in glassy needles has been found in one of the granite dykes in serpentine. Analysed by **J. T. Donald** it yielded Silica 46·24, Alumina 26·03, Lime 14·09, Water 13·88.

PETROLOGY.

590. Anon.—The Meteorite of Oschansk.

"Nature," vol. xliii., p. 228.

The descent of the meteor is described in "La Nature." It fell in Russia, Aug. 18, 1887. Six pieces of it have been found, one at Oschansk weighed 1·79 kil., and made a hole 50 cm. deep. One at Tabor, which broke in fragments of 98 kil., 11 kil., &c., weighed 328 kil. in all, and made a hole 4·20 metres deep. It belongs to the brechiform type, called "canellite."

591. Fletcher, L.—The Supposed Occurrence of Wide-spread Meteoritic Showers.

"Nature," vol. xliii., p. 295.

This is a full abstract of the paper in the "Mineralogical Magazine" [No. **538**, 1890].

***592. Rudler, F. W.—The Present Aspect of the Jade Question.**

Rep. Brit. Assoc. for 1890, p. 971.

It was formerly thought that the European and American jade implements must have been made from material imported from Asia, but the author notes that nephrite has now been discovered in Silesia and Styria, and jadeite has occurred as a pebble near the Lake of Geneva and in Piedmont. Boulders of jade partially worked have been found in the Frazer River Valley, and the mineral also *in situ* in the Jade Mountains of Alaska.

593. Lapparent, A. de.—On the Porphyritic Rocks of the Island of Jersey.

Quart. Journ. Geol. Soc., vol. xlvii., p. 35.

This contains the same information as his paper in the Comptes Rendus, *see* 1890, No. **558.**

594. Gregory, J. W.—The Variolitic Diabase of the Fichtelgebirge.

Quart. Journ. Geol. Soc., vol. xlvii., p. 45.

The pearl-like spheroids which occur in this rock have been described by Dr. Gumbel as rounded and baked inclusions of the surrounding slates, but by Rosenbusch and Zirkel as varioles. The locality studied is round Berneck. Near the uppermost Œlschnitz bridge is a spheroidal diabase of close grain, with bands of variolite not confined to the surface. The ground mass is green, and consists of isotropic matrix, with needles of plagioclase and granules of augite. The varioles are white, externally altered, with radiating needles of plagioclase from several centres, and intercalated granules of augite. He quotes an analysis of Gumbel's, showing 64·33 per cent. of silica from these varioles, but he has no confidence in its correctness [!]. All the rock contains circular vesicles filled with chlorite. The microscope thus shows the identity of this rock with the variolite of Mt. Genèvre, but it is not a mere contact product, and is often amygdaloidal.

Another mass described is an intrusive mass near the path

to Heinersruth. In this the ground mass contains needles of actinolite, and the varioles have no radiation, and are composed entirely of alteration products. "Yet," he adds, "the whole structure of these spherulites shows that they are more primitive than the others, and due to a more rapid and imperfect development." The principal types of rock in this district are:—(1) compact diabase, with abundance of leucoxene; (2) amygdaloidal diabase with actinolite needles and vesicles mostly of calcite. He concludes that the imperfect varioles characterise the selvedge, and the perfect ones the interior. There are bands of minute cracks, crossing both varioles and matrix; they are filled with calcite or dolomite. They have been called "pseudo-crystallites," but there is here no doubt as to their nature.

The Diabase is intrusive, and has no associated tuffs, though one of the neighbouring grits looks like one.

Amygdaloid has often been mistaken for variolite, but the true variolite is particularly associated with spheroidal structure, and he thus explains its origin:—"The diabase rapidly cooling by conduction of its heat to the neighbouring rocks, contracted into great spheroids, which while semi-viscid on the periphery, were still fluid within; under the pressure of the forces that drove them upwards these rolled over one another and were drawn out into oval masses. It was during this process that the felspathic and pyroxenic constituents began to crystallise out around various points; the plagioclase needles forming radiating clusters between which the augite granules were wedged in; as these half-formed varioles were rolled over, still other layers of the variolitic constituents were deposited around them; when the varioles were originally in close contact, these later layers enclosed several and built up the compound varioles."[1]

***595. Cole, G. A. J.—Devitrification of Cracked and Brecciated Obsidian.**

Miner. Mag., vol. ix., No. 44, p. 271.

The fragments of obsidian which, in a brecciated example from the lava-flow at Rocche Rosse, have developed a spherulitic structure growing inwards from their surfaces, and the finer fragments in the matrix have developed the same structure; in fact, spherulitic growth has started from every crack, or other line of separation. The result, when the fragments are narrow, closely resembles a number of axiolites, but differs in the growth having taken place inwards instead of outwards, leaving clear glass in the centre when there is room. The

[1] The figures of rock sections accompanying the paper are not explained, and in the first a variole is drawn bounded by an irregular dark coat, the nature of which is not stated.

spherulites are produced by prolonged heat short of that required for re-fusion.

596. Lucas, R. N.—Notes on the Older Rocks of Finland.

Geol. Mag., Dec. 3., vol. viii., p. 173.

The author believes that from his former description [*see* No. **664**, 1890], it is shown that there is a constant succession of three members in the Archæan rocks:—1. Granite-Gneiss. 2. Grey Micaceous Gneiss. 3. Hornblende-Gneiss. He acknowledges, however, that this order is not observable in the British Isles; that there is no evidence of excessive pressure in the majority of these gneisses, and that most, if not all, of the crystalline, apparently interbedded, limestones are of the nature of veins.

The acid eruptive rocks are of two kinds:—I. The Gneiss-Granite. This is a facies which may be assumed by granites of any age, especially near the edges, the foliation being parallel to the strike of the gneiss. Its eruptive origin is shown by the neighbouring gneiss being impregnated with granite magma. The foliation is ordinarily due solely to the orientation of the mica,[1] whereas in the gneiss all the elements are orientated. In one case at Mankila "the quartz individuals are found as a species of laminæ," and these, and not the mica, produce the orientation.

II. "Rapakivi," a local name for a rapidly decaying rock. It occupies 4,900 square miles, and the country is low and flat, except for dome-shaped protuberances ["hummocky appearance" of Geikie]. It consists of pink orthoclase, aggregating into large spheroids, each of which is coated with oligoclase, and they lie, with ½-in. crystals of quartz, in a matrix of black hornblende and mica. Microcline is also present. Where there is most oligoclase the rock is most weathered, and to the abundance of this ingredient, therefore, the peculiar weathering is assigned. There is another mass to the west with separate orthoclase crystals, and no oligoclase or microcline, and, unlike the other, it has greatly squeezed the surrounding rocks.

***597. Harker, A.—On various Crystalline Rocks (Woodwardian Museum Notes).**

Geol. Mag., Dec. 3, vol. viii., p. 169.

I. Pyroxenite (Websterite) from Fobello, Italy.—This "consists of large plates of diallage moulding smaller grains of hypersthene, neither mineral having any external crystal form." The hypersthene shows pink and green pleochroism, and the diallage has solution-planes parallel to the ortho-

[1] That is to say, he distinguishes between "quincuncial" or "linear" and "elemental" or "laminar" orientation.

pinacoid; a little hornblende occurs at the contact of the two minerals. The rock thus belongs to the rare family of the Pyroxenites. It is not stated whether the rock occurs in a mass, dyke, or vein.

II. Eclogite from Port Tana in the north of Norway.—The garnets are slightly double-refracting by strain, and contain rods parallel to their axes, which may be cyanite. The omphacite has associated quartz, which shows undulose extinction, and contains rods and hair-like crystals of rutile.

IV. Quartz-diorite from Viti Levu, Fiji.—This shows lustrous black crystals of hornblende, and flakes of golden brown mica, in a mass consisting mainly of plagioclase felspar. The latter is idiomorphic and zonal, with wider extinction angles towards the centre, and is moulded by the other minerals. Quartz occurs interstitially.

V. Uralitised gabbro from Eua, Tonga Islands [*see* No. **550**].—This is a "fine-grained, crystalline aggregate, in which little patches of black hornblende are seen moulding the dull whitish felspars." The latter are idiomorphic plagioclase, the former is pseudomorphic after augite, of which unaltered kernels remain. "The structure of the rock points to a plutonic orgin."

598. Holland, T. H.—Notes on the Rock-Specimens collected by W. Gowland, Esq., A.R.S.M., F.I.C., F.C.S., in Korea.

Quart. Journ. Geol. Soc., vol. xlvii., p. 171.

The specimens are from a different part of the country from that visited by Dr. Gottsche in 1883.

Granite forms the summit of most of the hills, and breaks through the crystalline schists. It is described as typical granite, with enlarged orthoclase crystals and secondary quartz. There is also granitite and aplite, and veins of eurite.

Felsite, with fluidal structure, and altered andesites occur, the latter with outgrowths of quartz crystals, like "babel" quartz, and showing also damascened structure.

Of the Intermediate type, diorite occurs, with glomero-porphyritic structure, both basaltic and common hornblende, and zoned plagioclase. Also devitrified andesites, showing the structures of propylites. The dark microliths indicate a fluidal structure, and there are glomero-porphyritic enclosures. In another the microliths are closely felted, and bands of granophyre, in which the felspar is kaolinised, show a centric arrangement. The plagioclase is schillerised in four distinct planes and then surrounded by a fresher, more acid zone. One of these andesites is vesicular, the vesicles being filled with opal. There is possibly also tridymite, and the felspars are partly kaolinised and partly converted into epidote.

The basic rocks are the latest, they are dolerites and

basalts, one is fresh and micro-ophitic, and another shows inclusions of quartz crystals, which have produced a felsitic zone round them. Numerous more detailed observations are given in the paper.

The gneisses are mostly biotite-gneisses, but one is a muscovite-biotite-gneiss, with microperthitic structure, and evidences of pressure; others are augen-gneisses showing "mörtel-structur." One contains dichroite, of which statement he gives an analysis in proof. Hornblende schists and quartz-mica schists also occur. One of the sedimentary sandstones shows secondary growth of quartz around its grains.

599. Bonney, T. G.; Raisin, Miss C. A.; and Jones, T. R.—Report on some Rock Specimens from the Kimberley Diamond Mines (with a Note).

Geol. Mag., Dec. 3, vol. viii., p. 412.

Some specimens have been picked up in the refuse heaps at Kimberley, and the names of the minerals or rocks represented are here printed.

600. Tenne, C. A.—Note on the Geology of the Kilimanjaro Region. "Across East African Glaciers." By Hans Meyer.

London: Philip & Son. Crown 8vo, pp. 346—351.

In the steppes between Ndara and Taveta the gneiss, which on the west side of the mountain dips west, is overlain by sandstones and limestones. The Ugweno country consists of crystalline schists with specular iron ore, decomposing to laterite, whence the natives smelt iron. The dip on the west side is high to the west, on the east side to the east; but there are divergences on the higher grounds. The rocks from Kilimanjaro have been described by Dr. J. S. Hyland in Tschermak's Min. und Pet. Mitth. x., and his statements are discussed. The rocks consist of pegmatite, one gneiss, one amphibolite, felspathic-basalt, tephrite, nepheline-basanite, leucitic basanite, nepheline-basalt, limburgite, and basaltic obsidian.

601. Derby, O. A.—On Nepheline Rocks in Brazil. Part II. The Tingua Mass.

Quart. Journ. Geol. Soc., vol. xlvii., p. 251.

Tingua is a conical parasitic peak of later date on the Serra do Mar, behind Rio de Janeiro. It has been opened up to investigation by the water supply for Rio being taken from it, for which ditches and trenches have been cut. The predominant type of rock is either the orthoclase-nepheline combination called foyaite when holocrystalline (he will not adopt the term tinguaite, which is founded on a misconception), and phonolite when porphyritic. These pass into each other. The phonolite occurs as dykes, but in one place, at

least, as an effusive mass, accompanied by tuff. The foyaite is thus considered eruptive and volcanic; it differs from a deep-seated mass in its mode of occurrence, its irregular (*schlieren*) structure, and its trachytic habit. It is nowhere seen in the form of a dyke, but lies in one place, at least, as a sheet on the surface of the gneiss, and its broken-up form may be due to the previous decay of the rock on which it lies. It shows fluted weathering in places, and there are segregations of porphyritic type, which form groups of pseudo-crystals, up to 7 in. in diameter, having the external form of leucite; crystals of orthoclase and other minerals sometimes cross the boundary; they seem to have acted as nuclei. The main mass of the pseudo-crystals is of secondary consolidation. The whole exhibits zonal structure, especially in the central portions. He suggests that these pseudo-crystals may have been really leucitic, though full of inclusions, and have been subsequently pseudomorphosed into orthoclase and nepheline. There are also more basic masses, whose relations are undetermined, but which have been called "a peculiar group of augitite" by Rosenbusch.

***602. Rutley, F.—On a Spherulitic and Perlitic Obsidian from Pilas Jalisco, Mexico.**

Quart. Journ. Geol. Soc., vol. xlvii., p. 530, pl. xviii.

The Obsidian is leek-green with brownish-red spherulites. The first formation is a banded fluxion structure. The spherulites were the next to form, they are sometimes arrested at a fluxion-band, and they start again at the other side, and sometimes there is one within another. The perlitic cracks are complex, several being within a larger one. They accommodate themselves to the spherulites, and never cross them, showing that they are a subsequent formation. There are also partial radial cracks, and both these and the concentric ones are filled with chalcedony, bounded with globules of the same, which makes them look broader. The glass is rendered dull by the development of minute globulites, &c., as in obsidian from Vulcano, where exposed to sulphurous steam. The plate gives figures of these structures.

***603. Harker, A.—Notes on a Collection of Rocks from the Tonga Islands.**

Geol. Mag., Dec. 3, vol. viii., p. 250.

This consists of notes on the specimens brought home by J. J. Lister [*see* No. **550**]. No lava flows have been seen, but there is a boulder of grey compact andesite, composed of little plagioclase crystals in an isotropic ground-mass, and there are dykes of rocks of similar character, with felspathic veins. The clastic rocks are stratified in finer and coarser bands,—in the latter case he calls it a volcanic sandstone, the fragments being of a brown-stained, glassy lava; some

are hardened by calcareous matter. In the latter are chips of characteristic "metamorphic" minerals and tests of foraminifera, &c. The matrix also contains radial, but non-concentric oolitic concretions. The overlying calcareous rocks contain similar concretions and organic remains. The rocks of Mango are tuffs with microlitic andesite, also volcanic conglomerates and calcareous chalky-looking rocks. Some from Nomuka-iki are ashes of andesite, with felspar and pyroxene, and are non-calcareous. On Tonumeia are similar ashes, and black nodules, partially manganiferous. Tonua yields calcareous ashes.

The Falcon Island [*see* No. **45,** 1890] consists of volcanic dust similar to that from Krakatoa, with fragments of plagioclase, augite and rhombic pyroxene. There are also agglomerates. The ejected blocks are vesicular, basic, augite-andesites, with porphyritic crystals of bytownite. With the exception of those of the Falcon Island all the materials are of submarine origin.

ECONOMICS.

604. Newton, E. W.—The Metalliferous Minerals of Australia.

59th Annual Rep. Roy. Cornwall Polyt. Soc., p. 117.

A brief account of the mineral wealth of each of the Colonies, together with Tasmania and New Zealand.

605. Wilkinson, C. S.—The Mineral Resources of New South Wales.

Journ. Soc. Arts, vol. xxxix., p. 835.

The yield of coal in 1890 was 3,060,876 tons. There are three principal coal-bearing series, viz., the Greta and West Maitland seams of Carboniferous age, the East Maitland seams, and the Newcastle seams. All of them contain *Glossopteris*—the *Lepidodendron* beds lie below and yield no coal. There is an aggregate of 130 ft. of coal, the thickest being 32 ft. The Talbagarai and Clarence coals are of Triassic age. The total amount of workable coal, over 2½ ft. thick, believed to be in N.S. Wales within 4,000 ft. of the surface is 78,198,200,000 tons.

Kerosene Shale is contained in the Middle and Lower Coal-measures. Details are given of the amounts obtained of gold, silver and lead, tin, copper, antimony, iron as magnetite and limonite, manganese, chromite, cobalt, bismuth, mercury, zinc, tungsten, platinum *in situ* in ironstone lodes, alumstone, diamonds in superficial deposits, about 50,000, (near Bingera, the largest 5 carats) slates and flags, building stones, as sandstone, granite with adularia, syenite and marble, and infusorial earth of Tertiary age.

606. Wilkinson, C. S.—On the Mineral Resources of New South Wales.

Rep. Brit. Assoc. for 1890, p. 805.

The total value of the minerals raised in New South Wales to the end of 1889 is £81,598,113. The total value of the coal raised to the end of 1889 is £22,787,155. There is also kerosene shale. The total gold is valued at £36,614,887. Silver lead has been raised to the value of £4,909,952, tin ore to £8925,543, copper ore to £5,645,027, antimony to £73,501. There also deposits of iron ore, chromite, cobalt, manganese, bismuth, mercury, wolfram, scheelite, blende, and alunite. 50,000 diamonds have been found, and sapphires, topazes, beryls, garnets, and zircons are of frequent occurrence. Building stones, marbles, serpentines, and pottery and brick clays occur in abundance.

607. Waller, T. H.—Notes on some Ores from the Barrier Ranges, New South Wales.

"Midland Naturalist," vol. xiv., p. 256.

A general account of the district and its mines, which yield chlorides, iodides, and bromides of silver and galena. There is very little water.

608. Halse, E.—Some Banket Deposits of the Gold Coast, West Africa.

Trans. Federated Inst. Min. Eng., vol. ii., p. 69, plates vii.—xii.

These deposits lie on the east side of the Ancolia River, which runs south to Axim, west of Cape Three Points, while there are true quartz veins on the west side. It is called the Wassaw country, and lies some 40—60 miles from the coast; the hills range N.N.E. and S.S.W., and the Banket deposits are approximately parallel to them. In the Taquah Mine the conglomerates (bankets) are irregular, separating and joining together again. The rock consists of quartz grains with titaniferous iron-ore in layers, with plates of talc. The width varies up to 18 ft., the bottom 6—12 in. having the most gold, yields 5—7 dwts. per ton, the best assaying 9 dwts. 18 grs., and where the titaniferous iron is thickest 13 dwts. 16 grs. The beds in the Abosso Mine are more regular, they dip at 35° to N.W. The succession downwards is Red Clay, Sandstone, Grit, Auriferous conglomerate, and Grit; the auriferous beds are 5½ ft. thick, the lowest layer assays 4 oz. 17 dwts., and runs up occasionally to 15 oz. 12 dwts. The gold varies from the size of a pin's head to an impalpable powder, and occurs chiefly in the cement.

Six other mines are briefly described. The rocks are not much consolidated, and it is thought that they are of no great age. No eruptive rocks or faults have as yet been discovered in the district.

609. Moss, E. W.—Observations on the Distribution and Economic Value of Tin Ores in the Malay Peninsula.

Rep. Rugby School Nat. Hist. Soc. for 1890, p. 17, with a map.

A general notice of the stream tin of Banca and the vein tin of Perak.

610. Miller, C. C. H.—The Phosphate Fields of Florida.

The phosphate occurs in two forms, the River or Nodular Phosphate and the Rock Phosphate. The former is found in banks in the midst of the rivers Peace and its tributaries, the St. John's River, and the upper waters of the Alafia. The nodules are washed out of the adjoining strata during the floods and left as bars during the droughts. Many nodules are simply rolled bones and are black in colour. Deposits of brown nodules are also found at the mouth of the Manatee River. Round the head-waters of the Alafia the deposit, which is of an amber colour, is found *in situ* only. It is close below the surface, and the bottom has not been reached; an average cubic yard contains 600—1,200 lbs. of phosphate. The Rock Phosphate occurs in pockets, the best being in hardened masses requiring blasting, and the rest in small pieces mixed with sand and clay, running to a thickness of 30—40 ft. The best known are in Marion County, on the Withlacoochee River.

In some cases the phosphoric acid is united with iron and alumina instead of with lime.

The following analyses are given.

1, Peace River (average of 5 analyses); 2, Black River; 3, Polk County, Land Nodules (average of 2); 4, Hernando County, Rock Phosphate (average of 5 analyses); 5, Dunnellon District (average of 3):—

	1	2	3	4	5
Phosphoric acid ..	28·26	24·15	33·16	35·45	36·72
Lime	42·03	36·99	44·84	47·29	50·11
Oxide of Iron ..	1·96		2·31	0·74	0·65
Alumina				1·61	1·65
Siliceous matter ..	—	29·60	9·75	8·44	3·46
Magnesia	—	—	5·37	5·25	
Carbonic acid ..	—	—	1·82		

Also another set by **F. Wyatt,** 1, Boulder Phosphate; 2, Boulders and *Débris*; 3, Soft White; 4, unselected:—

	1	2	3	4
Phosphoric acid ..	34·15	29·70	32·50	13·80
Lime	42·10	38·20	41·70	27·40
Oxides of Iron & Alumina	6·32	9·42	8·70	18·65
Insoluble	5·20	13·25	5·20	31·00
Carbonic Acid.. ..	1·80	2·10	4·80	3·16
Fluorine	1·70	1·49	1·15	0·37

611. Bell, W. A.—Mineral Resources of Colorado.
Royal Scottish Geograph. Soc., vol. vi., p. 525.

Deals principally with the economic side of the subject.

***612. Walker, G. B.—Notes on the Coal-fields of New South Wales.**
Trans. Federated Inst. Min. Eng., vol. ii., p. 268, pls. xxv.—xxviii.

Gives a general summary of the knowledge possessed of the various coal-fields in the Newcastle and Illawarra districts, and the thickness and qualities of the coals, followed by economic statistics of output, exports, &c. Appendix B gives the sections of various sinkings.

***613. Cox, S. H.—The Coal-fields of Australasia.**
Trans. Federated Inst. Min. Eng., vol. ii., p. 321.

A table of analyses, by various authors, of the different Australasian coals is given, and then some details of the coal-fields at Newcastle, N.S.W., Buller, N.Z., Brunner, N.Z., Kawa-Kawa, N.Z., Lake Macquarrie, N.S.W., Illawarra, N.S.W., Mountain, N.S.W., Queensland, Tasmania, Kaitangata, N.Z., Shag Point, N.Z., Whangarei, N.Z., Malvern Hills, N.Z., Waikato, N.Z., and Green Island, N.Z. On the first of these only are any considerable geological details given. The Hawkesbury sandstone is said to be unconformable on the Coal-measures below Sydney. At Holt, Sutherland, a bore hole 2,307 ft. deep—the deepest in Australia—only reached coal at 2,226 ft.

***614. Topley, W.—The Sources of Petroleum and Natural Gas.**
Journ. Soc. Arts, vol. xxxix., p. 421.

Petroleum may either be formed by the decay of organic bodies or by the sinking of water, carbonated or otherwise, to great depths, where iron, in combination with carbon, or potassium, or sodium exist. If the former is the case the supply is necessarily exhaustible, if the latter, it need not be. Petroleum generally occurs where the rocks are thrown into gentle anticlinals, or where there is an interruption of dip. Such beds, traced to the outcrop, contain water, like other porous rocks, and it is the pressure of this water which produces the pressure in the gas. An account of the oil fields of America is then taken from Professor W. F. McGee, by which it appears that a gas-field is in the form of a dome of porous rock overlain by an impervious one; the gas is at the top, then the naphtha, if present, then petroleum, and, finally, bitter water. The static pressure, *i.e.*, when the oil is not running, varies from 300—900 lbs. per square inch. Petroleum was first called "Seneca oil," being obtained by the Seneca Indians as early as 1627. The oil-bearing beds

belong to the Trenton Limestones, the Devonian and Carboniferous. The capacity of these beds may range from 0·1 per cent. to 10 or 12½ per cent., and some are 500 ft. thick.

Details are given of the amount of oil, or the place of its occurrence in the United States, Canada, Mexico, Venezuela, Trinidad, Columbia, Peru, Argentine Republic, Egypt, Algeria, India, Burmah, Japan, China, New Zealand, the Caucasus, the Carpathians, Germany, Italy, France and Spain, and the United Kingdom.

In the Caucasus the wells are in an anticlinal, the oil coming from loose sands which ascend with it, and more oil comes up from the wells than can be secured. In the Carpathians the beds yielding oil are highly contorted Tertiary and Cretaceous beds. North of Hanover the oil lies in horizontal clay bounding a mass of rock-salt. In England some oil was recently discovered near East Grinstead, in Wealden beds, at 512—521 ft. below the surface.

***615. Topley, W.—The Geology of Petroleum and Natural Gas.**

Geol. Mag., Dec. 3, vol. viii., p. 508. Abstract of paper read at the Brit. Assoc. in Aug., 1890.

A brief account is given of the geological position of gas and oil, viz., a small quantity in trachyte breccia at Taranaki, N.Z., and in trachyte tuff in N.W. Hungary. In Devonian and Lower Carboniferous Sandstone in Pennsylvania and New York. In Trenton Limestone in Ohio and Indiana, where anticlinals occur, and where the limestone is dolomitised and porous. In Lower Coal-measures in Kansas. In Upper Devonian Shales in Kentucky and Tennessee. In Cretaceous Shales in Colorado, and in Tertiary strata in California. In Devonian anticlinals in Canada, also in Trenton Limestone. In Devonian rocks in the N.W. Territories. In Cretaceous strata in Athabasca and the Rockies. In Tertiary beds in Mexico. Possibly in sub-Cretaceous rocks in the Argentine Republic. In Keuper beds in Germany. In Jurassic rocks in the Rhone Valley and Savoy. In Neocomian and Cretaceous rocks in the Pyrenees and Spain. In Oligocene in Elsass. In Lower Tertiary in Bavaria. In Eocene in Italy. In Neocomian to Miocene in Galacia and N.E. Hungary. In Miocene in Poland, Roumania, and the Caucasus, *i.e.*, Baku. In Lower Tertiary in Algeria. In Miocene in Egypt. In Lower Tertiary on the flanks of the Himalayas, and in Lower Burmah. In Newer Tertiary in Upper Burmah and Japan. In Cretaceous and Tertiary in New Zealand. The general geological conditions are: 1. They occur in rocks of all geological ages, from Silurian upwards. 2. There is no relation to volcanic action. 3. The most productive districts are where the strata are compara-

tively undisturbed, gas being mostly absent in contorted strata. 4. The main requisite is a porous reservoir, and an impervious cover. 5. An anticlinal structure is most favourable, the oil accumulating in the domes. 6. Brine is an almost universal accompaniment of oil and gas.

616. Ross, O. C. D.—The Origin of Petroleum.

Geol. Mag., Dec. 3, vol. viii., p. 506. Abstract of paper read at the Brit. Assoc. in Aug., 1891.

The author has a theory that petroleum is formed by the action of sulphurous gases, SO_2 or H_2S, emanating from volcanoes, upon beds of limestone, and gives the following equations:—

$$2Ca_2CO_3+2SO_2+4H_2S=2(Ca_2SO_4, H_2O)+4S+C_2H_4$$
$$Ca_2CO_3+SO_2+3H_2S=Ca_2SO_4, H_2O+3S+CH_4$$
$$Ca_2CO_3+H_2S+2H_2O=Ca_2SO_4, H_2O+CH_4$$
$$2Ca_2CO+2H_2S_3+2H_2O_2=2Ca_2SO_4, H_2O+C_2H_4.$$ [1]

He accounts for the great receptacles of oil and gas, associated as they constantly are by brine, as being the washed out cavities in great beds of rock salt.

617. Brindley, W.—On the Marbles and other Ornamental Rocks of the Mediterranean.

Rep. Brit. Assoc. for 1890, p. 809 ("Builder," Sept. 20, 1890, and "Building News," Sept. 19, 1890).

The Greek quarries of Pentelicus and Paros are still workable for white marble. The shores of Thessaly and Magnesia yield 16 quarries for green marbles, just rediscovered. The Imperial Red Porphyry from the Nile is now being reworked, and the blocks received in London still bear relics of the old tool-marks. The richest African marble is from Kleber, near Oran, and all the Spanish and part of the French coast of the Mediterranean is very rich in marble.

618. Dawson, Sir W.—Notes on the Useful and Ornamental Stones of Ancient Egypt.

Journ. Victoria Inst., vol. xxiv., p. ?

There are two rocks at Assouan (Syene) used for sculpture—the intrusive syenite, and a banded gneiss—the latter is sometimes porphyritic. The statue of Kephren, usually called diorite, is a gneissic anorthosite, mostly composed of felspar, but true diorite used as in the Rosetta stone, and a dark grey granite as at Karnac. Chips of a basalt, with possibly olivine, now decayed, occur plentifully on the Pyramids plateau.

The Nubian Sandstone is siliceous, the angular grains being loosely cemented. It is the premier rock of the country.

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[1] The author writes Ca_2 instead of Ca, but this does not affect the equations, but are any such reactions known in the laboratory? Is H_2S so abundant in volcanoes? and is petroleum connected with volcanoes? [*See* No. **612**].

Short notes are given of the Nummulite Limestone, of a later limestone near Alexandria, and of alabaster from the cliffs of Beni Suef, west of the Nile, where it occurs like a stalagmite.

The Miocene Silicified Sandstone of Jebel Ahmat, near Cairo, has been used for the Sphinx shrine in the temple of Pithom, &c., but not for the Colossi of the plain of Thebes, which are of Nubian Sandstone.

Twenty-one other kinds of stones and gems are enumerated. The flints are obtained from the Eocene Limestone series, they were more plentifully used in earlier times, and were used for cutting the hieroglyphics; on the introduction of metal their manufacture deteriorated.

MISPLACED.

619. Buchanan, J. Y.—On the Composition of Oceanic and Littoral Manganese Nodules.

Trans. Roy. Soc. Edinburgh, vol. xxxvi., pt. ii., p. 459, and two plates.

This consists of details of the methods and results of analyses of several nodules, some of which were collected on the "Challenger" expedition and some in Loch Tyne mud; amongst the latter some are attached to shells as figured.

620. Worth, R. N.—Estuaries and Tidal Lands of Plymouth.

Ann. Rep. and Trans. Plymouth Institution, vol. xi., p. 65.

Sections in various estuaries and lakes are drawn and described, showing the thickness of the silt and the form of the rock bed beneath. Many are taken from the sections of the creeks crossed by the Cornish Railway. From these the conclusion is deduced "that the rock-bed of the Hamoaze and associated estuaries forms a channel varying from 60 ft. to 150 ft. in depth, steadily growing deeper seawards, and with ever-increasing rapidity, presenting constant alternations of wide-spreading basins with much-contracted straits." "The agency which would have created these singularly-shaped excavations we must" "decide" was "ice-action." The remainder of the paper deals with the reclamation of the land in historic times.

621. Wentzel, J.—Ueber die Beziehungen der Barrande'schen etagen, C., D., und E. zum Britischen Silur [On the Relations of Barrande's Stages C., D., and E. with the British Silurian].

Jahrbuch k.k. Geol. Reichs. Wien, Bd. xli., p. 117.

A very important paper full of detailed comparisons

of different groups of fossils in the subdivisions of strata adopted in Bohemia and England, comparing them one by one. The result, however, is rather disappointing. It does not appear to have been possible to correlate the two series very closely; the final result being that the Cambrian up to the Tremadoc = C, the Llandeilo and Arenig together = Dd_1, Dd_2, the Caradoc = Dd_3—Dd_5 and the Silurian as a whole = Ee_1, Ee_2. But there is much more in the paper than this final result.

622. Stainier, X.—Report of the Excursion of the Royal Malacological Society of Belgium to the County of Kent; 15—17 August, 1890.

Annales Soc. Roy. Malacol. Belgique, tom. xxv., p. 63.

The Society were guided to Herne Bay, Sheppey, and Folkestone by J. S. Gardner. At Herne Bay the members agreed with the views of that author (Q.J.G.S., vol. xxxix.) that the Oldhaven beds form the base of the London Clay series, as the Lower Bagshot sands form their top. At the bottom of the Oldhaven beds was seen a bed of black rolled pebbles, and below this the fossils of the so-called Woolwich beds, above the zone of *Corbula regulbiensis*, were thought to have little resemblance to the typical Woolwich fossils, but to greatly resemble the fossils of the beds below. They accepted, therefore, the view that the Woolwich and Reading beds are not here represented, but that the whole belongs to the Thanet Sands.

The author gives a lively account of their doings; the first day lasting from 2.45 a.m. to 1 a.m. the following morning.

623. Thomas, T. H.—Handbook for Cardiff and District—Geology.

Cardiff: 8vo, pp. 244. pp. 208—228.

Gives an account of the Silurian beds of Pen-y-lan. In a thin band of bluish-black mudstone some finely preserved small stems of *Nematophycus* and remains of *Pachytheca* [*see* No. **379a**], also of the Old Red Sandstone, Lower Carboniferous Shales, Carboniferous Limestone and its fissures; the Millstone Grit; Magnesian limestone, which is seen lying unconformably on the Carboniferous Limestone in Sully Island, and on the S. of Whitesand Bay, Barry Island; the Dolomitic Conglomerate with its footprints of *Brontozoum*; the Keuper Marls; the Rhætic beds in which a fine bone bed has been found at the spot off Lavernock Point at ebb spring tide; the Lias and the Glacial and alluvial deposits.

624. Roberts, R. W. B.—The Cliff Sections of the Yorkshire Coast.

Journ. Liverpool Geol. Assoc., vol. xi., p. 59.

Gives a general account of the rocks exposed in the cliffs from Flamborough to Whitby.

625. Pritchard, J. R.—The Boulder Clay of the North End of Liverpool.

Journ. Liverpool Geol. Assoc., vol. xi., p. 52.

At Linacre are heaps of boulders, one of which is a block of limestone with tubes [*Syringopora* ?], another is a Liassic ammonite from Antrim, and a felspathic rock banded with hornblende. From the material from Bootle Docks have come a tooth of *Acrodus*, pieces of Keuper with gypsum and salt pseudomorphs, and many flints. From the brickfields, Badford Road, have come numerous broken bivalves, and unbroken univalves. In the worked-up marls below the Boulder Clay at the brick and tile works, Moor Hey, are a few striated erratics, one of greenstone. In the Boulder Clay are shell fragments and blocks of wilhelmite, hemimorphite, and hæmatite, and one limestone block has a serpula on it, another is bored by lithodomi.

'626. Geikie, J.—On the Scientific Results of Dr. Nansen's Expedition.

Roy. Scottish Geogr. Mag., vol. vii., p. 79.

The former occurrence in Greenland of plants like those of South Italy only shows that the *winter temperature* of the country was then higher. This difference, combined with cool and humid summers, would, as in the case of the interglacial floras and faunas, permit the intermingling of plants, which are now very differently distributed; and, generally, in the past, the climates have been more "insular," and the land was much more broken up, hence "warm currents flowing uninterruptedly through polar regions" enabled the now fossil flora and fauna of Greenland to exist.

627. Boulenger, G. A.—Notes on the Osteology of *Heloderma horridum* and *H. suspectum*, with Remarks on the Systematic Position of the *Helodermatidæ*, and on the Vertebræ of the Lacertilia.

Proc. Zool. Soc. for 1891, p. 109.

This deals with recent forms, but in the discussion of the systematic position of the family, he gives notes on the position of *Glyptosaurus*, *Mesosaurus*, &c., and regards the *Dolichosauria*, so far as the structure of the limbs and vertebral column is concerned, as the progenitor of the order Squamata, thus—

Riptoglossa

Pythonomorpha Lacertilia Ophidia

Dolichosauria

628. Williamson, W. C.—On the Organisation of the Fossil Plants of the Coal-Measures. Part XVIII.

Proc. Roy. Soc., vol. xlix., No. 298, p. 154.

An abstract of a paper describing the fruit of *Bowmannites*, a Calamarian plant, in the fructification of which the foliar verticils are replaced by a broad circular disk, the margin of which sustained a verticil of leaf-like "disk-rays." The upper surface of the disk is covered by sporangiophores, each sustaining a single sporangium. The spores have a distinctive form. A plant under the name of *R[h]achiopteris ramosa* is also described.

629. Lewis, G.—A Geological Sketch of the Town and District of Nottingham.

Proc. Chesterfield and Mid. C. Inst. Eng., vol. xviii., p. 58, plates ix. and x. = vol. ii. Trans. Federated Inst. of Min. Eng., plates ii. and iii.

The author says that only the fringe of the coal-supplies has as yet been touched. He gives an account of the different coal seams of the district, and their position in the Measures is given in plate iii. He gives Coal, 4 ft., at 688 ft. below the surface; the Top Hard, 4 ft., at 1,419 ft.; the Waterloo Coal, 7 ft., at 1,559 ft.; the Brown Rake Ironstone, 4 ft., at 1,860 ft.; the Black Band Ironstone, 3 ft. 8 in., at 1,890 ft.; the Bottom Soft Coal, 3 ft., at 1,973 ft.; the Bottom Hard, 4 ft. 10 in., at 2,015 ft.; the Piper, 4 ft. 8 in., at 2,061 ft.; the Furnace Coal, 3 ft. 5 in., at 2,174 ft.; the Black Shale Coal, 5 ft., at 2,334 ft.; the Kilburn Coal, 3 ft., at 2,767 ft.; and an unnamed coal at 3,074 ft.

The map is on a scale 3 miles to the inch, and gives only the general features, but some underground faults in the Leen Valley are added. Three run N.N.W. with westerly downthrows of 21 ft., 60 ft. and 67 ft. respectively, and two run E. by N. with northerly downthrows of 54 ft. and 14 ft. respectively.

630. Mills, M. H.—A few Notes on the Ironstone Deposits of Leicestershire.

Proc. Chesterfield and Mid. C. Inst. of Engineers, vol. xviii., p. 64 = vol. ii. Trans. Fed. Inst. of Min. Eng.

The author by no means feels sure that all the ironstones of Leicestershire belong to the Marlstone, as stated by E. Wilson. There are no Lias clays above them, and he is not aware that the Marlstone fossils have been found in them.[1]

631. Rudler, J. W.—On the Source of Jade used for Ancient Implements in Europe and America.

Journ. Anthrop. Inst., vol. xx., p. 332.

A fuller paper on the same subject as No. **592**, but with no further geological information.

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[1] In some places they are almost made of *Terebratula punctata*.

SUPPLEMENT FOR 1890.

1S. Balderston, R. R.—The Cambrian Rocks and Silurian Base of Ewcross, Dufton and Shap Wells.

Lancaster: 1890, pp. 25 and map (privately printed).

Not seen. Reviewed by A. H. [arker] in the "Naturalist" No. 187, p. 63, where it is stated that the author "utterly ignores fossil evidence, and does not appear to have examined the rocks themselves any more minutely than can be done in the field."

2S. Brockbank, W.—The Levenshulme Limestones.

Mem. and Proc. Manch. Lit. and Phil. Soc., 4th series, vol. iii., p. 209.

Describes the section 50 yards west of Slade Lane, where current-bedded red Permian Sandstone rests on an apparently eroded surface of Coal-measures, the uppermost of which are purple and green marls and fine purple grits, like the *Modiola Macadami* beds of Sutton, and below these come the Levenshulme Limestones.

[For full details, *see* No. **104,** 1891.]

3S. Dowker, G.—The Beds between the Chalk and London Clay in East Kent.

"The South-Eastern Naturalist," vol. i., p. 12.

Discusses the question whether the green-coated flints at the base of the Thanet Sands were collected into a bed before the deposit of the sand, or afterwards. The theory of T. McK. Hughes is that the bed is due to the decomposition of the chalk *after* the deposition of the Thanet Sands; the theory of the author is that they are the result of subaerial denudation before the chalk was depressed to receive the sands, though the tabular flint was produced afterwards by the silica of the sand being brought into contact with the chalk. It is noted that the flints and overlying sand go down into the pipes, but are not more numerous there. The overlying sands are unfossiliferous for 30 ft. at Elham, and then comes a fossiliferous clay. He is inclined, therefore, to make another subdivision of the Lower Tertiaries, calling it the "Basement bed of the Thanet." A bibliography of 57 papers is added.

4S. Shone, W.—The Deluge; a Tradition of the Glacial Period. Also Appendix to the same.

Two pamphlets, privately printed, Chester.

The tradition of a flood is confined to the same limits as the effects of the Glacial epoch, *i.e.*, to the area of the Mongoloid nations. He considers that this epoch occupied the great break between Palæolithic and Neolithic man, taking the Somme Valley men as Palæolithic and the Cave men as

Neolithic [but is it between *these* that the great break has been made out?]. The ice-sheet depressed the land and submerged it, and this was the flood; as the ice melted the land re-emerged, this was the return of the waters off the land, and this was 50,000 years ago. The second pamphlet answers objections [but the main one which suggests itself is untouched, viz., that the Glacial epoch must have lasted over so many generations that no single story of its coming and going would ever have been put together].

5S. Tiddemann, R. H.—Handbook for Leeds.

Leeds: 8vo. Prepared for the British Association.

Contains a chapter on the Geology.

6S. Anon.—Geological Sections on the Manchester Ship Canal.

"Research," vol. ii., p. 232.

Reproduces two photographs taken by E. Ward of:—1. River and Drift Sands, with a pot-hole, at Barton. 2. A section of Waterstones at Norton, showing the slickensided face of a fault.

7S. De Rance, C. E.—Notes on the Geology of the Manchester Canal.

Trans. and Proc. Chesterfield and Mid. C. Inst. Eng., vol. xviii., p. 1 = vol. i. Trans. Federated Inst. of Mining Engineers.

This consists of a general account of the systems of rocks believed to underlie the line of excavation. In the canal itself little has been observed, except erratics from the Lakes and Criffel, a sandstone at Barton, old river gravels and alluvium. At Partington, the Lower Keuper Sandstone is met with, leading to Waterstones, and between Thelwall and Latchford soft yellow Upper Bunter Sands overlain by purple Boulder Clay and later sands.

8S. Anon.—Geology of the Isle of Man.

"Manchester Examiner," Aug. 9, 16, 23, 30, and Sept. 6.

A series of popular articles. The first gives a sketch map showing Drift, Carboniferous Limestone, Basement beds, Volcanic Rocks, Skiddaw Slate (the bulk of the island), Granite, and Pikrite. These are separately dealt with in the subsequent articles, which are obviously written by a well-informed geologist.

9S. Haydon, W. T.—A Neolithic "Find" near Dover.

"The South-Eastern Naturalist," vol. i., p. 33.

In the Hougham Road a considerable collection of flints was found lying in a depression in the chalk, the greatest depth being 6 ft. Below this was a soft clayey deposit in which fragments of charcoal, pottery, horse bones, and a limpet shell and two flint implements were found. This

shows that the flints are not simply the result of ordinary subaerial denudation, and he suggests that the spot is the site of a "hut circle," which was covered over by the flint during a sudden flood due to an excessive rainfall on some occasion.

10S. Jaekel, Otto.—*Acanthoteuthis* **aus dem unteren Lias von Lyme Regis in England.**

Sitz. Ber. Ges. Naturforschender Freunde zu. Berlin, No. 5, p. 88.

A purchased specimen, when worked out, showed the muscular mass turning to dust on contact with the air, the outline of the body with the fins attached, the head, the funnel, and the base of the arms. There are also two predatory arms. There are four hooked arms on the side preserved, and probably eight in all.

The body is cylindrical, about 3½ times as long as wide, the fins at the hinder end are three-sided, with a base one-third the length of the body. The ink-bag is large, club-shaped, opening near the upper edge of the mantle; the funnel opens in front of it. The pen is thin, small, and feebly calcareous, and not clearly seen. The circular fibres of the muscles of the mantle are clearly seen. The head is sharply set off from the body, and is a little smaller than it. The outline of one eye is seen. The arms are connected by strong muscles to the head. The hooks begin at some distance and are in a double row. Each row has about 20 hooks, largest in the middle, knife-like, and the point but little bent. All the arms are united at the base by a common skin, and there may have been a fifth pair. These characters would assign it a place amongst living cuttles in the family *Onychoteuthidæ*, between *Enoploteuthis* and *Veranya*, but its correlation with fossil forms is a more difficult matter, but they are not Octopods, as Zittel makes them, and are far removed from the Belemnoteuthidæ.

11S. Burrows, H. W.; Sherborn, C. D.; and Bailey, G.—The Foraminifera of the Red Chalk of Yorkshire, Norfolk, and Lincolnshire.

Journ. Roy. Microscopical Soc. for 1890, p. 549, pls. viii.—xi.

The material described has been partly obtained from a small collection from the softer band of the Red Chalk at Hunstanton, but the remainder are all from the Speeton cliffs, with the exception of some slices of Red Gault and Chalk, described separately. The following is the list, all except *Orbulina universa* and *Pulvinulina Menardi* being figured:—

Nodosaria calamorpha.	Cristellaria cultrata.
——— limbata, 1.	——— gibba.
——— obscura.	——— italica, 1.
——— prismatica.	——— variabilis, 3.
Dentalina soluta.	——— lata.

Dentalina communis, 1.
——— brevis.
——— filiformis.
——— marginulinoides.
——— mucronata.
——— abnormis.
Marginulina inæqualis.
——— glabra.
——— variabilis.
Lingulina carinata, 1.
Frondicularia biformis.
——— gaultina.
——— Archiaciana.
Rhabdogonium tricarinatum.
——— minutum.
Vaginulina eurynota.
——— recta.
——— arguta.
——— legumen.
Cristellaria rotulata, 1, 2, 5.
Cristellaria multiseptata.
——— crepidula, 1, 2, 3, 4, 5.
——— Marckii.
——— cymboides.
Polymorphina lactea.
——— communis.
——— amygdaloides.
——— horrida.
Ramulina aculeata.
Globigerina bulloides, 1, 2, 4, 5.
——— cretacea, 1, 2, 3, 4, 5.
——— Linnæana, 1, 4.
Sphæroidina bulloides.
Truncatulina variabilis.
Planorbulina ammonoides, 1.
Anomalina grosserugosa, 1.
Polystomella macella.
Orbulina universa, 2, 3, 4.
Pulvinulina Menardi.

It is noted that some of these (as marked in the list) occur at other localities, viz., 1, Hunstanton; 2, Candlesby; 3, South Cave; 4, Great Givendale; 5, Wharram Grange. In addition, *Textularia pygmæa*, *T. trochus*, *T. turris*, *Bulimina Presli*, *Lagena brevis*, *L. apiculata* occur at Hunstanton; *L. apiculata*, *N. radicula* occur at Candlesby; *L. apiculata* at South Cave, *Lagena lævis*.

The species in the slices of rock from 24 localities are named.

128. Seward, A. C.—Notes on *Lomatophloios macrolepidotus* (Goldf.)

Proc. Cambridge Phil. Soc., vol. vii., part ii., p. 43, with pl. iii.

An addition to the description by Professor Weiss. The fossil consists of a stout axis, with sack-like leaf-bases, enclosing a flask-shaped space with elliptical bodies, supposed to be sporangia. He states that these have central vascular bundles, and are, in reality, stigmarian rootlets belonging to another tree. The central axis is similar to that in *Favularia*, as described by Williamson. Some still smaller opaque bodies he takes for coprolites of boring annelids. This so-called cone of fructification is therefore "simply a flattened portion of a lepidodendroid plant, which has lost its woody axis, also the innermost and middle cortical tissues."

138. Solms-Laubach, H. Graf zu.—On the Fructification of *Bennettites Gibsonianus*, Carr.

Botanische Zeitüng, 1890. Translated in "Annals of Botany," vol. v., p. 419, pls. xxv., xxvi.

Bennettites is the name of the fossil stems from the Cretaceous rocks of the Isle of Wight, which are usually called Cycadean, having been described by Carruthers as

forming a family called Bennettiteæ, and as belonging to that order. The present author considers the fruit, which was described by Carruthers, to be so distinct from that of the *Cycadeæ* that the two cannot be included in the same order, and as all the so-called Cycads agree in their vegetative organs with the *Bennettiteæ*, and the only fruit known, viz., that of *B. Gibsonianus* distinguishes these from *Cycadeæ*, it follows that no true *Cycadeæ* are certainly known from the Secondary rocks, but all may be *Bennettiteæ*.

The author has examined some freshly cut slices from the original specimen of *B. Gibsonianus* from the Greensands of Luccomb Chine, and gives an account of the fruit. The spadices are not absolutely proved to be axillary, but there is nothing to show that the stem was a sympodium. There is no trace of the bundle-system of the stem running into the pith, as in the fruit-bearing end of the axis in *Cycadeæ*. The spadices terminate small lateral shoots, and are covered by thin leaves, the whole being covered by the base of the stem-leaves. The base of the spadix is an expanded cushion, on which each seed is supported on a stalk, and the seeds lie in a simple peripheral layer surrounded by the closed tissue of the external layer, the pits in which each seed fills. The seeds show the embryo, with radicle, hypocotyl, and two fleshy cotyledons lying one on the other. The testa has a tubular prolongation beyond the seed proper, and pushes through the narrow orifice of the seed-pit till it reaches the surface of the fructification. The external layer of the fruit may possibly be formed from the structures between the cords, which overlap the seeds, and unite externally to form a continuous layer.

The *Bennettiteæ* thus show a greater complexity in the structure of the flower than the *Cycadeæ*, but have a simpler structure of the vegetative organs.

148. Hatch, F. H.—Petrographical Tables.

London: Swan Sonnenschein & Co. 4to.

Translated from Professor Rosenbusch's "Hülfstabeln zur Mikroskopischen Mineralbestimmung in Gesteinen." The tables are of—I. Singly refracting minerals; II. Doubly-refracting uniaxial minerals; III. Doubly-refracting biaxial minerals. In each case there are given: the crystalline system, the characters of the cleavage, the characteristic form, the optical character, the principal zone or face, the form and optical character of the principal zone, the colour, pleochroism, index of refraction and of double refraction, optic orientation, the optic axial angle in air, dispersion, specific gravity, behaviour with reagents, chemical composition, and remarks. The first table contains 23 minerals, the second 35, and the third 102, or 160 in all.

15S. Dick, A. B.—Notes on a New Form of Polarising Microscope.

London: Swift & Son, 8vo, pp. 56.

First there is a description of the "Dick" petrological microscope, in which the analyser and polariser are rotated together while the object remains stationary, and special arrangements are made for the observation of the figures in convergent polarised light. A method is then given for making a mica wedge by first determining the optic axis of a plate, by making a star with a needle, and then splitting the plate into thinner flakes, and dividing it into strips which are then placed one over the other, so as only partially to overlap, like tiles—we thus get a step-like wedge of different thicknesses of the mica. The eye-piece micrometer is made to serve for the measurement of the angle between the optic axes by observing a piece of mica held in a forceps, which has to be rotated through an observed angle to bring the end of the optic axis to the central point of the eye-piece, and then noting the division of the micrometer on which the end of the optic axis of this plate rests, when the plate is turned back again so as to be symmetrical. Methods are then given for determining the angles of extinction, the major and minor axis of depolarisation, the positive or negative character of the double refraction, the dispersion, the pleochroism, and the strength of the refraction and double refraction. Next comes how to examine any rock-forming mineral, any sand and any rock, including MacSchuster's method of distinguishing the felspars, and finally, how to verify the instrument. The whole is written very lucidly, and from actual work with the instrument.

16S. Whitaker, W.—Coal in the South-East of England.

Journ. Soc. Arts, vol. xxxviii., No. 1953, pp. 543—557.

A general account of the uprise of older rocks underground and of the probable occurrence of concealed coal-fields.

17S. Robson, T. O.—Notes on the Variations in the Faulting of Coal, Observed in the Action of the same Series of Faults in Three Seams at Redheugh Colliery.

Trans. N. Eng. Inst. Min. Eng., vol. xxxviii., p. 49, pls. ii. and iii.

A series of faults have been traced downwards from the "Harvey Seam" into the "Basty Seam" 12 fathoms below, and still further into the Brockwell Seam 20 fathoms below. They change in character for:—

1. The dislocations are more frequent and decisive in the upper than in the lower seams.

2. The area affected in the upper seam is larger than in the one below, and in the latter larger than in the lowest.

3. The quality of the coal is deteriorated in the two upper seams but not in the lower seam.

4. In the two upper seams the floors and roofs are shattered, but they remain good throughout the lower seam.

Thus the dislocation decreases as the depth increases, and thus would ultimately disappear downwards.

Another fault is also described which changes from a "trough" fault through a "loop" fault to a "riser" by the disappearance of the "dipper."

18S. Addison, P. L.—Description of the Cleator Iron Ore Company's Barytes and Umber Mines and Refining Mills in the Caldbeck Fells.

Min. Proc. Inst. Civil Eng., vol. cii., p. 283.

The vein of umber is situated ½-mile to the west of High Pike, at a point called Harestones, at about 1,800 ft. above O.D. It lies in a decomposed felspathic rock forming china clay, and is 2—6 ft. wide. An analysis of the purified mineral gives:—

Peroxide of iron	47·14
Peroxide of manganese	11·17
Oxide of copper	3·23
Alumina	7·66
Silica..	24·70
Combined water	6·18

19S. Carus-Wilson, C.—Tables for use in the Lectures in connection with the Oxford University Extension.

Poole: C. J. Woodford, 8vo, pp. 12.

Gives the details of various subjects which require a tabular form. [The table of strata seems to need some revision.]

20S. Carus-Wilson, C.—Illustrations and Diagrams from the Works of Sir Archibald Geikie and others.

London: Macmillan & Co., 8vo, pp. 64.

Reprints of 186 illustrations in Geikie's Physical Geography, Class Book, Text Book, Geology, and Field Geology and Huxley's Physiography. It is very generous to allow these admirable wood-cuts to be printed separately, they form a concentrated storehouse for teachers and students.

21S. O'Reilly.—Sur les *Oldhamia* d'Irlande.

Assoc. Française Congrès de Limoges 1re Partie, p. 184.

Abstract, stating that the author considers there is not sufficient evidence for the organic origin of *Oldhamia*, which occurs in slates associated with eruptive rocks.

CORRECTIONS FOR 1890.

No. 76, line 15, after "fauna" read "as well as from independent evidence."
Table, p. 57, for "Rhync. etiensis" read "Rhync. letiensis"; for "Littor" read "Litton"; for "Pethenon" read "Petherwin"; before "Chudleigh Limestone" add "part of" twice; raise "Eifelian" parallel to "Combe."
No. 141, line 6, after "is" add "often contradictory, and so."
P. 58, for "Chinscombe" read "Churscombe"; for "Goodington" read "Goodrington"; and for "Maildon" read "Marldon."
P. 59, line 22, for "hebbomense" read "hebbornense"; lines 23—5, for "have . . . Endsleigh" read "rest on Eifelian slates, and in places on the limestones of that series"; last line, delete "Heliolites porosus."
No. 142, line 29, before "Quantock" read "northern parts of the"; line 31, after "as" read "also."
No. 196, line 10, for "He" read "The author."
No. 209, line 7, for "sketch" read "stretch."
No. 222, line 2, for "vol. v." read "vol. vi., p. 76."
No. 223, line 3, for "v" read "vi."
No. 243, line 16, for "then" read "thin."
P. 146, line 14, after "difficult" add "also by their position on the same plane"; line 16, for "curious irregularity" read "curious exceptions to the general regularity."
P. 173, line 2, add "vol. vi., p. 20."
No. 354, line 1, for "islands" read "Highlands."
P. 188, line 25, for "no reason given for change" read "meant as a correction of Orthocosta."
No. 396, line 3, add "Nat. Hist. Trans. Northumb., Durh., and Newcastle-on-Tyne, vol. viii., p. 349."
No. 438, line 1, for "Townsend" read Townshend"; line 2, for "South" read "North"; line 6, for "Bickerton" read "Bickington"; line 9, for "at Saunton Court" read "from Saunton Court to."
P. 209, line 30, 1, delete "but . . . species."
No. 454, line 4, for "154" read "184."
No. 467, line 6, for "pingens" read "pungens"; line 11, for "bairdoides" read "Bairdioides."
No, 492, line 13, for "2,172" read "2,178"; line 18, for "Fenland" read "Tenland"; line 22, for "was a forest of" read "were many."
No. 501, line 4, for "referred" . . . "to" read "compared . . . with."
No. 525, line 14, for "these characters indicate" read "the position of the optic axial plane indicates."
No. 576, line 1, for "Irving, H.," read "Irving, A."; line 3, for "repeats . . . in less clear language" read "claims that . . . had been anticipated by himself"; line 7, delete "but, &c.," later papers showing that the author was justified in his objection.
No. 578, line 12, for "answeichungs" read "ausweichungs."
No. 589, line 5, for "lingulites" read "longulites."
No. 628, for "Baily" read "Barly" throughout.
No. 720, line 12, for "appendix, note T." read "p. 68, foot-note"; and for "intrusion of the Laurentian into the surrounding" read "inclusion in the Laurentian of masses of the overlying"; line 13, for "Keewat rocks, apparently" read "Ontarian of Lawson."

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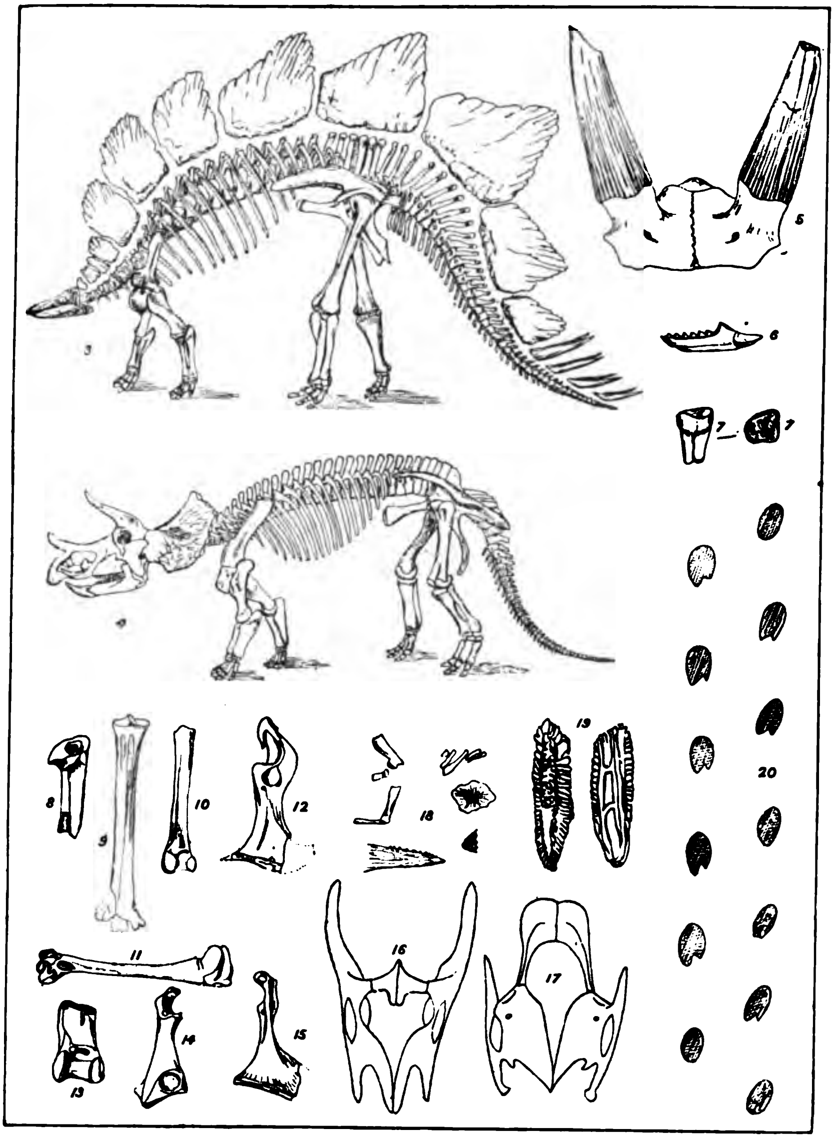

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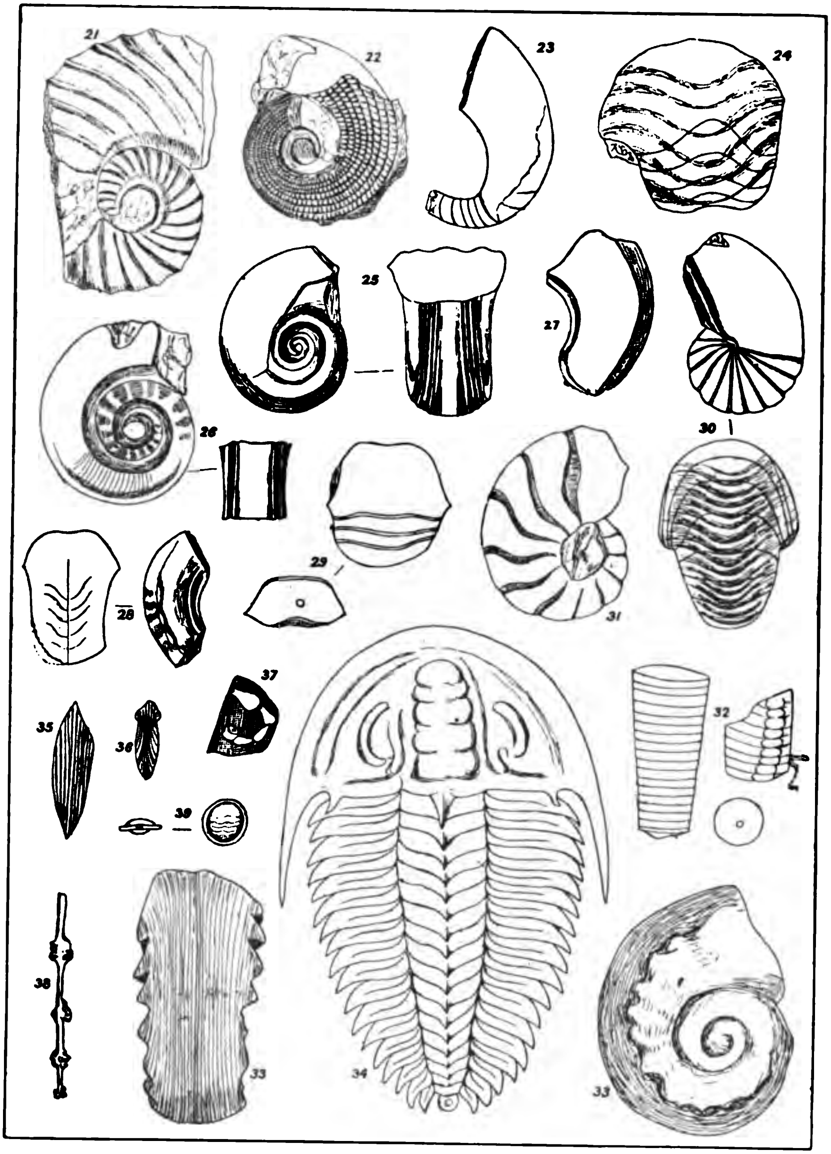

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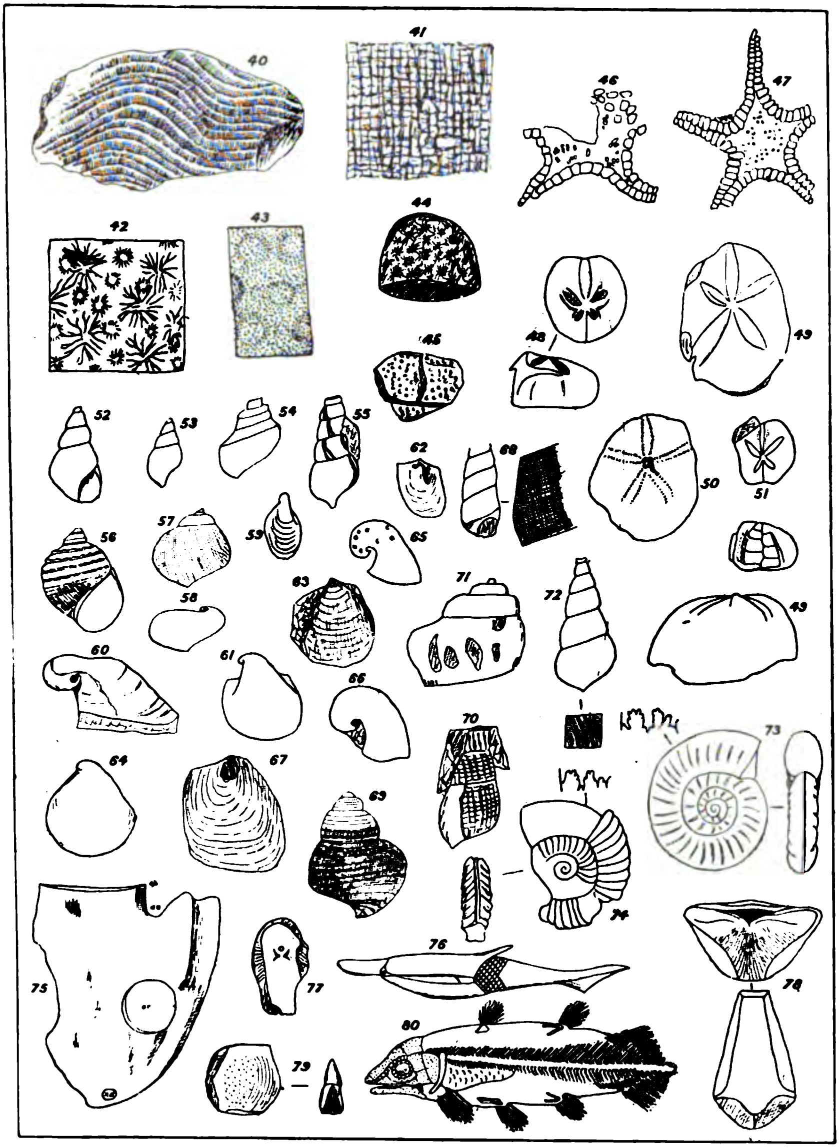

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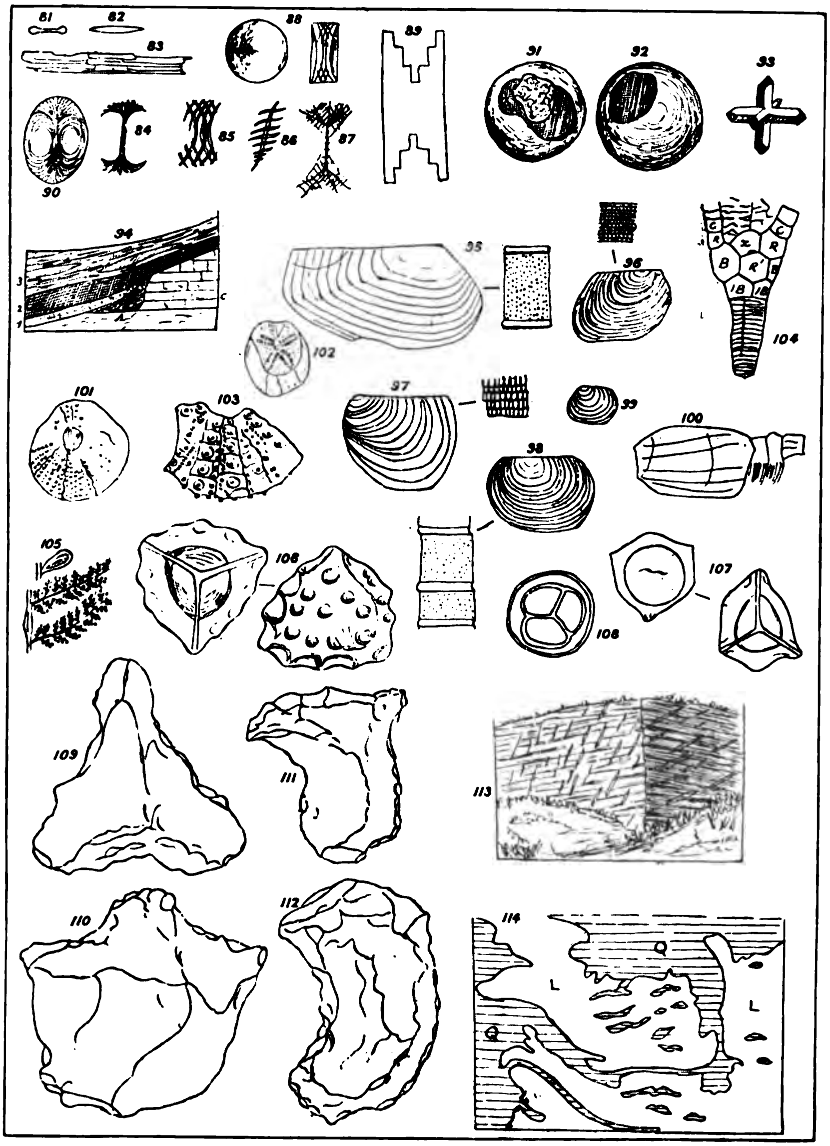

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